

Characteristics of children with florid vitamin D deficient rickets in the Auckland region in 1998

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Abstract

Aim. To describe the characteristics of children with vitamin D deficiency rickets and identify common features and predisposing factors.

Methods. A review of the clinical notes of all children less than five years of age with radiological evidence of rickets and serum 25-hydroxyvitamin D levels of less than 10 µg/L. Patients were identified by searching all low vitamin D levels performed at the Endocrinology laboratory at Auckland Hospital and children presenting to the Starship Childrens' Hospital with rickets in 1998.

Results. In 1998, there were eighteen children (ten males and eight females) with vitamin D deficient rickets. The age range was 3 to 36 months with a median of 12 months. There were twelve children of Indian ethnic origin, one

Maori, one Tongan, one Western Samoan, one Ethiopian, one Moroccan and one Indonesian. All children had an elevated alkaline phosphatase level and most had very low serum 25-hydroxyvitamin D levels (≤ 5 µg/L), and over half were hypocalcaemic. The common presenting features were delayed walking and bowed legs, swollen wrists or ankles, hypocalcaemic seizure, incidental radiological abnormalities and failure to thrive.

Conclusions. There are a significant number of children in Auckland presenting with florid clinical rickets. The majority with vitamin D deficient rickets in this survey were of Indian ethnic origin. Strategies are needed to detect children at risk of vitamin D deficiency and supplement them with vitamin D.

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Vitamin D is a secosterol hormone which is produced in the skin after exposure to ultraviolet light, or is ingested in the diet. The main function of metabolically active vitamin D is to facilitate the absorption of calcium, and phosphate from the intestine. The major circulating form of vitamin D measured in serum is 25 hydroxyvitamin D (25-OH-D) which reflects the vitamin D status of the body.¹ The reference ranges quoted for 25-OH-D levels are variable, but a value of less than 10 µg/L (conversion factor to nmol/L= $\times 2.496$) is considered to be subnormal.^{2,3} This cut-off level is supported by data from the national nutrition survey in the UK, of children aged 1.5-2.5 years.³

Rickets is characterised by defective bone mineralisation in children. Vitamin D deficiency is the commonest cause of rickets and may result from lack of sun exposure, dietary deficiency or malabsorption.¹ Factors associated with an increased risk of rickets secondary to vitamin D deficiency include: dark skin colour, minimal exposure to sunlight, iron deficiency, prolonged exclusive breast feeding and a restricted maternal diet (eg vegetarian).^{4,5} Except in the first weeks when the vitamin is acquired by the foetus during pregnancy, vitamin D status in infants is determined predominantly by exposure to sunlight. Based on a study of 61 infants relating sun-exposure to serum 25-OH-D, estimated sun exposure required to maintain vitamin D levels in infants is 30 minutes a week wearing only a nappy, or two hours a week with clothes but without a hat.⁶ Dietary intake of vitamin D is less important, although a vegetarian diet has also been associated with vitamin D deficiency.^{5,7}

Natural dietary sources of vitamin D include egg yolk and fatty fish (salmon, tuna).⁸ Cow and human milks are low in vitamin D (0.3 µg/L and 0.4 µg/L respectively),⁹ compared with foods which are fortified with vitamin D, such as margarine and infant formulas. The recommended daily intake for infants is between 7 and 8.5 µg/day, in the UK.²

No data exist on the vitamin D status of New Zealand children, and the extent of nutritional rickets in New Zealand is unknown. This survey was undertaken of children with low vitamin D levels and rickets to assess the clinical characteristics and identify common epidemiological and biochemical features.

Methods

All serum 25-OH-D levels performed on children less than five years of age, at the Auckland Hospital Endocrinology laboratory during the 1998 calendar year were reviewed. From these were selected all children less than five years of age with serum 25-OH-D levels less than 10 µg/L. A search was also made of the Case Management System database at Auckland and Starship Childrens' Hospitals from January 1 1998 to December 31 1998, using the ICD-9 diagnostic code for rickets. The hospital notes of the children were then reviewed, and those with radiological evidence of rickets were included. The radiographic changes consisted of rachitic rosary on chest radiograph and/or fraying, widening and cupping of the metaphyses of long bones.

Data were abstracted from the clinical notes that described; age, ethnicity, suburb, diagnosis, mode of presentation and treatment. The serum 25-OH-D levels, calcium, phosphate and alkaline phosphatase results were documented if available. If the 25-OH-D levels were requested by the general practitioner, the practice was telephoned and the same information collected. Factors associated with 25-OH-D deficiency such as maternal diet, maternal vitamin D status, feeding history and sun-exposure were abstracted if recorded.

Results

In 1998, there were 111 serum 25-OH-D levels performed on children less than five years of age, excluding repeat levels on the same patient. Of these, 30 children had levels of less than 10 µg/L. There were twelve children excluded from this study; six with malabsorption of vitamin D, three without evidence of rickets, two with other causes of rickets and one lost to follow-up. Included were eighteen children less than five years of age with a serum 25-OH-D level less than 10 µg/L and radiological evidence of rickets; the characteristics of these children are summarised in Table 1. There were ten males and eight females. The age range was 3-36 months (median twelve months). The majority (12/18) of the children were of Indian ethnic origin (including Fijian Indian and Sri Lankan). The remainder included two Pacific Island children, one Maori, one Ethiopian, one Moroccan and one Indonesian. There were fifteen children from Auckland suburbs and three from outside the Auckland area (two from Rotorua, one from Whangarei).

Most children (15/18) had very low vitamin D levels (≤ 5 µg/L). Three (Cases 6, 14 and 16) had 25-OH-D levels of 9 µg/L, and all of these had radiological evidence of

Table 1. Children with vitamin D deficiency rickets: clinical details and serum biochemistry.

Case number	Age at diagnosis (months)	Sex	Ethnicity	25 (OH) D (µg/L)	Mode of presentation	Total Calcium (mmol/L)	Phosphate (mmol/L)	Alkaline phosphatase (U/L)
1	3	M	Maori	<2	Failure to thrive	2.42	0.80	1715
2	7	M	Indian	<2	Hypocalcaemic seizure	1.82	0.87	>1000
3	8	M	Sri-Lankan	<2	Failure to thrive	2.02	ND	1416
4	9	M	Indian	<2	CXR for pneumonia	1.88	0.88	>1000
5	10	M	Ethiopian	2	Febrile convulsion	1.92	1.12	>1000
6	10	M	Moroccan	9	Sibling with Rickets	2.35	1.38	780
7	10	F	Indian	<2	Diagnosis on CXR	2.26	0.71	555
8	11	F	Indian	<2	Hypocalcaemic seizure	1.42	1.84	775
9	12	M	Indian	<2	Hypocalcaemic seizure	1.46	1.54	1209
10	12	F	Tongan	<2	Fractured tibia	2.12	0.76	>1000
11	13	M	Indian	<2	CXR for bronchiolitis	1.87	0.80	>1000
12	16	F	Fijian Indian	4	Delayed walking & bowed legs	2.10	1.53	2570
13	18	M	Indian	4	Delay walking & bowed legs	2.29	1.50	>1000
14	18	F	Samoan	9	Bowed legs	2.30	1.20	529
15	19	M	Indian	5	Swollen wrists & delayed walking	2.20	1.20	2008
16	20	F	Indian	9	Deformed wrists	2.51	1.60	452
17	28	F	Indian	2	Swollen ankles & wrists	2.33	1.70	740
18	36	F	Indonesian	5	Abnormal gait & bowed legs	1.72	1.34	747
ND=not done								
Reference Ranges				14-76		2.25-2.75	1.2-2.0	80-350

advanced rickets. Two-thirds of the children presented during the six months from July to December (Winter-Spring). Four (22%) presented in August. All of the children had an elevated serum alkaline phosphatase, and over half had a low serum calcium (11/18), with seven also having a low serum phosphate. Four children had a low haemoglobin (<110 g/L) and two had a low ferritin. Ten children had a normal haemoglobin and two did not have a full blood count performed.

The most common mode of presentation was bone disease. Four children presented with delayed walking and bowed legs and three with swollen wrists and/or ankles. Four presented with seizures, and all of these children had serum calciums between 1.42 and 1.92 mmol/L. Case number 5 presented with a febrile convulsion and was picked up fortuitously on laboratory testing with a high serum alkaline phosphatase. Four patients were diagnosed on the basis of a radiograph performed for another reason. Three of these were noted to have rachitic rosary on chest radiographs of children with bronchiolitis or pneumonia. One child had radiological evidence of rickets noted on a radiograph of a fractured tibia. Two children presented with failure to thrive and another was diagnosed as he had a sibling with rickets.

Information on other factors known to be associated with vitamin D deficiency, such as sunlight exposure and vegetarian diet, was incomplete. The mother was noted to be vitamin D deficient in three cases. Two children were reported to be 'fussy eaters' and five families were documented as being vegetarian. Four children had little sun exposure. Breast feeding was documented in ten cases, and the range was seven months to three years, with a mean duration of sixteen months.

The treatment was a single-day large dose of vitamin D¹⁰ therapy in the majority (12/18) of cases, which consisted of

100 000-600 000 IU of calciferol in 50 000 IU tablets, which were crushed in 10 mL of peanut oil. One child was treated with 1-alpha-calcidol drops alone and some children were treated initially with calcium replacement and 1-alpha-calcidol drops. Information on treatment was not available in five children. Over two-thirds of the children (72%) had proven response to therapy on repeat radiographs or serum alkaline phosphatase. Of the thirteen children that responded to vitamin D therapy, six also received calcium. The remainder of the children have not been followed up as yet.

Discussion

We were surprised at the number of cases and the severity of vitamin D deficient rickets found in one year. This survey is likely to have included only a small proportion of children with vitamin D deficiency, as there will be others in the community not admitted to hospital, and also children with subclinical forms of vitamin D deficiency. In New Zealand, the major source of vitamin D is likely to be vitamin D₃ derived from sunlight. The low 25-OH-D levels in this survey were found in the later half of the calendar year, with a peak in August. More pigmented skin is less efficient in production of vitamin D and there is also less photosynthesis of vitamin D₃ in the winter months.¹¹ The majority of children with rickets in this survey were of Indian ethnic origin. Interestingly, neither Asian nor European ethnic groups were represented, despite being well represented in the Auckland population. The reasons for the predisposition in Indian children is unknown, but could be due to genetic, dietary or cultural factors.

All children in this survey had a high serum alkaline phosphatase, which has been shown in previous studies to be a better predictor of rickets than 25-OH-D levels.¹² Most of our children had a serum 25-OH-D of ≤5 µg/L. It is

possible that other children with nutritional rickets have levels in the lower end of the normal range and were missed by this survey.

Bone problems such as swollen wrists and bow legs were the most common presenting features of rickets. Most of the cases in our series had florid symptoms, suggesting that improved awareness of rickets and vitamin D deficiency as an entity would be useful.

This study is descriptive and limited since the information was incomplete for factors associated with rickets. Three mothers were documented to be vitamin D deficient, but this is likely to be an underestimate. It is also likely that other associated factors such as vegetarian diet, low sun-exposure and prolonged breast-feeding are underestimated or not measured, as they were often not recorded in clinical notes.

Most of the children had a response to therapy with vitamin D alone or with calcium. A recent randomised controlled trial found that calcium supplementation alone, or calcium plus vitamin D, was better than vitamin D alone for treatment of rickets in Nigerian children.¹³ The possible contribution of dietary calcium deficiency to rickets in our children was not assessed.

The major finding of this survey is that severe vitamin D deficient rickets is currently a problem in Auckland. Similar studies over the last few years have described cases of florid rickets in the UK and Canada.^{2,14} Our sample contained a predominance of Indian children. A recent nutritional survey of 618 Asian children (Bangladeshi, Indian or Pakistani) in the UK found 20-34% of children aged 1½-2½ years had suboptimal levels of vitamin D, and this was also associated with iron deficiency.³ This study confirmed the previously described association between vitamin D and iron deficiency.¹⁵ Iron deficiency impairs fat and fat soluble vitamin absorption. The high prevalence of iron deficiency in New Zealand children¹⁶ may be an important risk factor for vitamin D deficiency here, and could potentially be used to identify a group of children at increased risk of vitamin D deficiency.

In addition to causing rickets, vitamin D deficiency has other adverse effects on health. In a study of Ethiopian children <5 years of age, nutritional rickets (due to either vitamin D or calcium deficiency) was associated with a thirteen-fold increase in the risk of pneumonia after correction for confounders (family size, birth order, crowding and breast-feeding).¹⁷ It is interesting to note that the seasonal variability in incidence of vitamin D deficiency in our series is very similar to that reported for pneumonia hospitalisations in children. In a recently published study of paediatric pneumonia hospitalisations in Auckland from 1993 to 1996, 77% of the children were hospitalised during the six months from July to December. 27% of the children hospitalised with pneumonia were admitted in August.¹⁸

In New Zealand, low serum vitamin D levels that are clinically inapparent are associated with an increased risk of disease in adults. Serum vitamin D levels are inversely associated with relative risk of myocardial infarction¹⁹ and of diabetes and impaired glucose tolerance.²⁰ The vitamin D status of adult New Zealanders varies with ethnicity. Serum 25-OH-D levels are significantly lower in adult Pacific Islanders, and to a lesser extent in adult Maori compared to adult Europeans.²¹ No data exist on the vitamin D status of New Zealand children. Based on the known associations between vitamin D status and a number of adverse health outcomes in both children and adults, it seems important that the true prevalence of this micronutrient deficiency should be defined in New Zealand children, and its roles in health status need to be determined. Those children at high risk of nutritional rickets need to be identified, and these children and their breast-feeding mothers supplemented with vitamin D.

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Acupuncture should become more widely available on the NHS and family doctors should be trained in some of its techniques, a BMA inquiry has concluded. The therapy has proved effective in treating back and dental pain, nausea and vomiting and migraine, the BMA's Board of Science and Education has found after a two year study.

Acupuncture is one of the most frequently requested of the complementary therapies. Up to five million people may have consulted a therapist specialising in complementary or alternative medicine in the past year, the report says.

Welcoming the report, Dr Richard Halvorsen, a GP and press officer for the British Medical Acupuncture Society, said: "It indicates a complete change in the way that the medical establishment views complementary therapies." The study was commissioned in 1998 to "investigate the scientific basis and efficacy of acupuncture and the quality of training and standards of competence in its practitioners." It reviewed literature and current research on acupuncture and examined safety aspects, including adverse effects.