

SHORT REPORT

Nutritional deficits resulting from an almond-based infant diet

D. DORON,* K. HERSHKOP,† E. GRANOT*

Department of *Pediatrics and †Clinical Nutrition, Hadassah University Hospital and Hebrew University-Hadassah Medical School, Jerusalem, Israel (Correspondence to EG, Pediatric Gastroenterology Unit, Department of Pediatrics, Hadassah University Hospital, P.O. Box 12000, Jerusalem, Israel)

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Introduction

We present two infants who developed severe nutritional deficits while receiving an almond-based home made “formula” as the sole constituent of their diet. Both babies were fed what their parents have called “almond milk” – a commercially produced almond mash mixed with water to give a milky-looking drink. Following this diet one infant had hypocalcemia, rickets and iron deficiency anemia, and the other severe hypoalbuminemia with resultant peripheral edema. All abnormalities resolved following conversion to a balanced diet.

As this unique diet includes no dairy products, no eggs and no meat, we regard it as a form of a vegan diet. Indeed, the nutritional complications described here have previously been reported among children raised in communities in which strict vegan diets were followed. The literature regarding the effects of unsupervised vegan diets in infancy is reviewed. The hazards of dietary “fads” in infancy and the importance of adequate nutritional follow up by health care professionals is emphasized.

Case I

A six month old male baby was hospitalized with acute bronchiolitis. Two days prior to his admission he had suffered a brief tonic seizure following an apneic spell, but was discharged from the emergency room after several hours of observation. On the following day dyspnea worsened, blood tests revealed anemia of 80 g/L and hypocalcemia of 1.35 mmol/L ($n = 2-2.6$), and he was referred for hospitalization.

This infant was born at the 36th week of gestation, birth weight 2.1 kg (10th percentile). He was breast-fed for the first 3 months with good appetite and an appropriate weight gain (along the 10th percentile). At weaning, a cow's milk protein based formula was

started. Because of diarrhea and vomiting, attributed by the mother to cow's milk protein allergy, the diet was changed one week later by the parents to “almond milk” (almond mash mixed with water – contents are detailed in the discussion).

Upon admission he was found to have a temperature of 37.6°C, heart rate of 135/min, and regular respiratory rate 68/min with mild dyspnea. Weight 5.3 kg (<3rd percentile), height 62 cm (3rd percentile). On examination – ear, nose and throat – normal. Examination of the skull revealed craniotabes, and rachitic rosaries were palpated at the costochondral junctions. On auscultation to the lungs prolonged expirium and scattered expiratory wheezes were heard. The remainder of the physical examination was unremarkable.

Laboratory results: Hemoglobin 77 g/L, MCV 68, WBC 9400/mm³ with a normal differential count, platelets 426000/mm. Blood chemistry revealed abnormalities suggestive of rickets with hypocalcemia of 1.4 mmol/l ($n = 2-2.6$), phosphate 1.2 mmol/l ($n = 1-2.1$), alkaline phosphatase 818 U/l ($n = 150-420$), total protein and albumin – normal. Parathyroid hormone level was increased to 30.3 pmol/l ($n = 1.2-6.8$), compatible with secondary hyperparathyroidism. An X-ray of the wrist revealed splayed, cupped epiphyses, consistent with rickets. Chest X-ray was normal.

The child's respiratory condition improved rapidly following treatment with inhalations of adrenalin, and apneic episodes did not recur. Failure to thrive, anemia, hypocalcemia with rickets and the history of unusual “health food formula” all suggested malnutrition secondary to dietary inadequacy. The child was fed a casein hydrolysate formula (Pregestimil, Mead-Johnson) and treated with oral calcium gluconate, vitamin D and iron supplements. On this regimen serum calcium levels were corrected and hemoglobin level increased. Weight gain during the first month after discharge was 900 grams. Calcium and vitamin D supplementation were discontinued one month later, and the child gradually regained normal growth along the 10th percentile.

Case II

An eight month old infant was hospitalized for evaluation of peripheral edema and hypoalbuminemia. The infant was born on the 38th week of gestation following a normal pregnancy and delivery, birth weight 2.6 kg (30th percentile). On the sixth day of life he was diagnosed as suffering from vesico-ureteral reflux and posterior urethral valves, which were treated surgically. Because of persistent vesico-ureteral reflux, prophylactic antibiotics were administered and routine kidney function tests performed monthly.

A nutritional history revealed that during the first four months of life the infant was fed a cow's milk protein based formula, with good appetite and a weight gain along the 50th percentile. This diet was changed, on the advice of the infant's pediatrician, to a soy-based formula because of a facial rash. As the rash persisted the formula was changed, by the mother, on her own accord, to "almond milk", occasionally enriched with honey.

Upon admission: Weight 8.3 kg (greater than 25th percentile), height 65 cm (3rd percentile). The physical examination was normal except for mild edema of the extremities, and a papular rash on both cheeks.

Laboratory results: Complete blood count – normal. Glucose, urea, electrolytes, calcium, phosphate – normal. Total protein 36 g/L, serum albumin 20 g/L. Urinalysis normal, with no evidence of proteinuria.

Clinical course: upon admission the infant was treated with i.v. albumin 20% at a dose of 1 g/kg, and feeding of a casein hydrolysate formula (Nutramigen, Mead-Johnson) was begun. This diet was well tolerated and serum albumin levels gradually increased. At discharge, 10 days after admission, serum albumin was 31 g/L. On follow-up visits 1 month and 3 months later serum albumin was 42 g/L and 36 g/L, respectively and normal growth was maintained along the 50th percentile.

Discussion

The two infants reported, both presented with severe nutritional deficits while receiving a diet based on "almond milk". This "natural food" formula consists of a commercially produced almond mash to which water is added. It is sold in 'health-food' stores and although not marketed as a milk substitute for infants it is commonly regarded as an alternative to cow's milk in infants with cow's milk protein allergy.

The possibility that our patients' symptoms are a result of an allergy to almond proteins was entertained but seems unlikely. Both infants had no diarrhea, no occult blood in stools and no protein-losing enteropathy, as evidenced by normal levels of stool alpha₁ antitrypsin (<1.0 mg/g dry weight).

The almond mash is made of peeled fresh sweet ground almonds. It contains, per 100 grams, (based on

the product's label) 600 Kcal, 50.4 grams of fat, 23.6 grams of protein and 3.9 grams of carbohydrate. The concentration of this 'formula' as reported by the parents was 10 grams of almond mash per 100 ml of water for patient I (daily intake – 1000 ml) and 20 g/100 ml for patient II (daily intake – 600 ml). Neither of the infants received vitamin and mineral supplementation and no solid food was begun.

Table 1 compares the nutritional content of the 'almond milk' (10 g/100 ml) to a standard commercial infant formula (Similac, Abbot). The specific vitamin content of the almond mash is not reported though almonds are known to be rich in group B vitamins but lack vitamins A and C (1).

The adverse nutritional effects of an almond-based diet described in this report, although not specifically addressed in the literature, are not uncommon amongst older patients receiving a vegan diet. Most of the information regarding the effects of such diets – which exclude meat, dairy products and eggs (2) – originate from studies in children raised on strict vegan diets for cultural and religious reasons. These nutritional complications were also relevant in the cases presented.

Case I presented with clinical features of rickets, which is a well documented complication of alternative diets (3–7). Dwyer and colleagues (8) have found the mean intake of vitamin D to be an eighth of the recommended daily allowance in macrobiotic diets. the 'almond milk' formula lacks in vitamin D and is low in calcium (17 mg/100 ml versus 56 mg/100 ml in standard formula). In addition, the presence of phytates reduces its bioavailability.

In addition to the chronic, morbid effects of rickets, hypocalcemia itself can result in acute, severe life threatening complications such as tetany and convulsions. Hellebostad et al. (9) described four children who, while receiving vegetarian diets, were hospitalized for evaluation of vitamin D deficiency rickets. All had marked hypocalcemia, and three had either tetany or convulsions. The hypocalcemic infant described in case I had a brief tonic seizure two days prior to his admission, but his serum calcium was not determined at that time. Convulsions have not recurred during a one year follow up period, and it is plausible that this episode was indeed a symptom of his severe hypocalcemia.

Table 1 Nutritional values of 'almond milk' compared to standard infant formula (per 100 ml)

	'Almond milk'	Similac
Energy (Kcal)	60	68
Protein (gr)	2.36	1.5
Carbohydrate (gr)	0.4	7.35
Fat (gr)	5.0	3.63
Sodium (mg)	0.4	23
Iron (mg)	0.32	0.15
Calcium (gr)	17	56
Magnesium (mg)	27	4.1

Table 2 Patients' intake vs RDA

	Patient I	Patient II	RDA
Energy (Kcal/kg/d)	113	84	100
Protein (gr/kg/d)	4.4	3.3	2.2
Calcium (mg/d)	170	197	600
Iron (mg/Kg/d)	0.6	0.4	1

Table 2 summarizes daily intake of energy, protein, calcium and iron as consumed by the infants presented, and compares these values to the recommended daily allowance (RDA) (10) for infants at the age of 6–12 months. The patient described in case II suffered from hypoalbuminemia and presented with peripheral edema, despite a seemingly appropriate protein intake. Yet, it is the quality of the protein rather than its quantity that is not sufficient. Proteins from non-animal sources tend to be deficient in one or more amino acids (11). Therefore, vegetarian diets must provide proteins from different sources in order to achieve complementary amino acids. A common example is that of cereal grains (rich in methionine but low in lysine) and legumes (containing lysine but deficient in methionine), each compensating for the limitation of the other (11, 12). Not all the essential amino acids are provided by the 'almond milk', as almonds are low in lysine and threonine (1). Thus, the consumption of a single plant source of protein such as almond cannot ensure adequate protein synthesis and growth.

When a vegetarian diet fails to provide sufficient protein, a negative nitrogen balance may ensue. This is further highlighted when the diet consumed is of low caloric value, leading to utilization of dietary protein as an energy source. A high rate of protein-caloric malnutrition has previously been reported by Shinwell and Gorodischer (13) in infants belonging to a vegan religious community in Israel. Anemia is another potential complication of alternative dietary practices in children, and indeed was manifested by one of our patients. Deficiency of both iron and vitamin B12 were found to be common among such infants (14). Serum vitamin B12 and iron levels were not determined in our two patients but the microcytic anemia present in patient I (MCV-68), the low daily intake of iron and the improvement observed following its supplementation are suggestive of iron deficiency. Furthermore, almonds are also poor in vitamin C, which is known to enhance the absorption of iron. Seshadri and colleagues (15) noted a significant improvement in the hemoglobin levels as well as in the red blood cell morphology of 54 anemic vegetarian preschool children following administration of ascorbic acid supplementation.

Despite the nutritional deficiencies discussed, infants and children can, obviously, be safely reared on vegetarian diets (16, 17). In such cases, however, close

medical supervision is mandatory. In the two cases presented, the decision to switch from a conventional formula to this unique regimen was made solely by the parents and without the seeking of nutritional advice regarding its adequacy. With the current flourishing of 'health food' stores, it is likely that an increasing number of infants will be exposed to inadequate, hazardous diets.

Indeed, twenty years ago, Roberts et al. (18) have suggested that the use of cult diets in infants 'should perhaps be regarded as a form of child abuse'. Thus, special attention should be given to the early identification of families at risk in which the parents practice unconventional food fads. Nutritional advice should be provided as part of the routine infant care, and the potential hazards of unbalanced diets emphasized.

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