Sodium, Calcium, and Magnesium Levels in Nails of Children with Cystic Fibrosis of the Pancreas

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Leonard, P. J., and Morris, W. P. (1972). *Archives of Disease in Childhood*, 47, 495. **Sodium, calcium, and magnesium levels in nails of children with cystic fibrosis of the pancreas.** Nail sodium, calcium, and magnesium levels were measured in 15 children with cystic fibrosis (CF) of the pancreas and compared with values found in 78 controls. There was a significant increase in the mean value of all three parameters in the CF group. There was an overlap in the values between the affected and control groups for all three measurements. Summing the sodium and calcium values or the sodium, calcium, and magnesium values gave a clear-cut separation between the groups, this being better in the latter case. It is felt that this approach might also prove fruitful in the detection of the heterozygote.

The incidence of CF of the pancreas has been reported as ranging from 1 in 400 to 1 in 4000 live births (Roberts, 1960; Steinberg and Brown, 1960; Honeyman and Siker, 1961; Pugh and Pickup, 1967; Hall and Simpkins, 1968). Thus it is one of the commonest inherited defects in infants. Sweat sodium levels are raised in CF of the pancreas and this measurement has been used extensively as a means of detection (Gibson and Cooke, 1959; Goldbloom and Sekelj, 1963; Warwick, 1966; Friedlander, Gasber, and Lieb, 1969). Raised levels of sodium were found in the nails of children with CF of the pancreas by Kopito *et al.* (1965), Shwachman and Kopito (1967), and Bock *et al.* (1967). Due to overlap in the levels found in CF children with those in healthy children, the usefulness of the nail test is confined almost exclusively to cases with clinical features of the disease and borderline sweat sodium levels.

In addition to the raised sodium levels observed in sweat and nails, a raised calcium level in submaxillary saliva has also been noted (Chernick, Barbero, and Parkins, 1961; Gugler *et al.*, 1967; Mandel *et al.*, 1969). This raised the question as to whether electrolyte abnormalities other than that of sodium existed in the nails of children with CF of the pancreas which may possibly enhance the diagnostic value of nail analyses. The advantages of such analyses as a screening technique are the ease of collection, storage, and transport of material

obviating the need to bring the patient to a specialist centre or bring sensitive electronic equipment to the patient. In the present study nail sodium, calcium, and magnesium levels were measured in children with CF of the pancreas, in children in hospital, and in healthy controls.

Materials and Methods

Nail clippings were collected from 93 children. These included 56 healthy children whose ages ranged from 6 months to 14 years, with a mean age of 5.3 years, 22 children who were admitted to hospital for a variety of reasons, whose ages ranged from 6 months to 10 years, with a mean age of 4.1 years, and 15 known fibrocystics whose ages ranged from 6 months to 6 years, with a mean age of 3.2 years. After drying to a constant weight the nails were got into solution essentially as described by Kopito *et al.* (1965). Calcium and magnesium levels were determined fluorometrically as described by Schachter (1959) and Phillips and Elevitch (1966), respectively. Sodium was measured by flame photometry.

Results

The mean results for the different groups are presented in Table I, and illustrated in Fig. 1 to 3. It can be seen that there was no significant difference observed between the mean values found in the healthy children and those in hospital for any of the parameters measured. There was a significant rise in the mean sodium, calcium, and magnesium levels in the fibrocystic group. Looking at

the distribution of the values found for each parameter separately, it is seen that there was an overlap

TABLE I
Mean Results from Analysis of Nail Clippings of 93 Children

Group	No.	Sodium ($\mu\text{g}/\text{mg} \pm \text{SD}$)	Calcium ($\mu\text{g}/\text{mg} \pm \text{SD}$)	Magnesium ($\mu\text{g}/\text{mg} \pm \text{SD}$)
Controls	56	3.34 ± 1.40	3.64 ± 1.77	3.45 ± 1.50
Hospitalized	22	3.67 ± 0.46	3.82 ± 1.35	3.41 ± 1.76
Fibrocystic	15	$9.12 \dagger \pm 3.20$	$9.96 \dagger \pm 3.70$	$4.72^* \pm 1.45$

Note: When compared with control group, $^* = P < 0.01$,
 $\dagger = P < 0.001$.

with the control group, being least for sodium and greatest for magnesium. Thus the diagnostic value of any one of these measurements on its own is greatly reduced. As there was a significant increase in the mean values for all three parameters, it was felt that a combination of these values might result in a clear-cut separation between the control and fibrocystic groups. In Fig. 4 the combined Na + Mg, Na + Ca, and Na + Ca + Mg values are plotted for the groups. The control and hospital groups were combined for this exercise, as no significant difference was noted between them.

FIG. 1.—Sodium levels in nails.

FIG. 2.—Calcium levels in nails.

FIG. 3.—Magnesium levels in nails.

FIG. 4.—Effect of summing the various electrolyte concentrations on the diagnostic value of nail electrolytes in CF of the pancreas.

It can be seen that summing the sodium and magnesium values did not completely separate the fibrocystic group from the controls, whereas summing the sodium and calcium values or the sodium, calcium, and magnesium values did. A better separation was achieved when all three values were combined.

Discussion

The present study confirms the finding of a raised mean sodium level in the nails of children with fibrocystic disease of the pancreas but with some overlap with the normal range as described previously (Kopito *et al.*, 1965; Shwachman and Kopito, 1967; Bock *et al.*, 1967). An additional finding is the raised levels of both calcium and magnesium, which does not appear to have been noted previously. It is felt that the diagnostic significance of nail electrolyte analysis is greatly enhanced by this observation as summation of the sodium, calcium, and magnesium levels leads to a clear-cut separation between the fibrocystic and

control groups. Thus at least for children over 6 months, there being none under this age in the group studied, this might prove to be a very simple and efficient screening technique. It would, however, have to be evaluated in this younger age group as it cannot be validly inferred that the same range of values would be found in healthy children of this age. For example, Lawson, Siggers, and Chapman (1967), measuring the sodium concentration of unstimulated parotid saliva, found a clear-cut separation between values found in 5 children with fibrocystic disease who were aged 3 to 4 months when compared with normal children of the same age. When compared with values obtained for children ranging from 1 day to 6 weeks, however, there was a big overlap.

It has been suggested that as many as 1 person in 16 may carry the gene for CF of the pancreas (Shwachman and Kopito, 1967). Detection of the heterozygote is therefore desirable. To date there appears to be no simple test which is useful in detecting the heterozygote. Sweat or parotid

sodium levels which are useful in detecting the homozygote appear to be of little use in identifying the heterozygote (Saggers *et al.*, 1967; Shwachman and Kopito, 1967). The results of the present study show the advantage of measuring nail sodium, calcium, and magnesium levels over nail sodium levels on their own in detection of the homozygote. It is suggested that this approach might also prove useful in the detection of the heterozygote.

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