Transcutaneous application of oil and prevention of essential fatty acid deficiency in preterm infants

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Abstract

The topical application of vegetable oil was assessed as an alternative means of providing essential fatty acids (EFA) to parentally fed preterm infants who were not receiving lipid. Three infant pairs ranging in gestational age from 26-32 weeks were studied. Safflower oil or safflower oil esters (1 g linoleic acid/kg/day) were applied to available areas daily. All infants rapidly developed biochemical EFA deficiency. The plasma fatty acid profiles were similar in infants with or without topical oil, and all returned to normal once parenteral lipid was introduced. We found no evidence to suggest that the transdermal route is of use in the nutritional management of preterm infants.

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Parenterally fed preterm infants rapidly become deficient in essential fatty acids (EFA) unless lipid is administered. Lipid emulsions, however, are often delayed or omitted because of their association with hypoxia and chronic lung disease,¹⁻³ and concern over interference with bilirubin binding.⁴

Our aim was to assess whether the topical application of a polyunsaturated vegetable oil could provide an alternative means of providing EFA. The transcutaneous route seemed a possibility as the preterm neonate has very permeable skin⁵ and drugs have been successfully administered to neonates by this means.⁶

Patients and methods

Infants of less than 2 weeks of age were studied, as drug absorption correlates well with epidermal structural maturation and by 2 weeks of age the rate of absorption is reduced to that of term infants.⁵ Three infant pairs were studied: (A) <1000 g, <28 weeks' gestation; (B) 1000-1500 g, 28-30 weeks' gestation; and (C) >1500 g, >30 and <34 weeks' gestation.

All infants were receiving total parenteral nutrition. Parenteral lipid was prescribed by the clinician when the infant was stable and jaundice had resolved. This varied from day 4-10 and was independent of the investigation.

Oil was applied to three infants while three others, who were matched for height, weight and days of fat-free alimentation, acted as controls. Safflower oil (Crisco Foods, Australia) was used for pairs (A) and (B), and safflower esters (Technu Laboratories, Australia) for pair (C). The esters were used to determine whether this form was better absorbed than the triglyceride (oil) form. The oil and esters contained 78% linoleic acid, 10% saturates and 12% monounsaturates. Vitamin E was added at 1600 IU/100 ml and all oils were stored at 4°C in the dark.

A small pilot study determined that the oil was not degraded by phototherapy (less than 1% change in the fatty acid composition over five hours). Similarly, another small study confirmed that there was no burning of preterm skin under lights and heaters after oil application.

The infant's gestational age and birth weight, the number of days that oil was applied and the day parenteral lipid was commenced are given in the table. The mean daily dose of linoleic acid was 1.1 (range 0.7-2.2) g/kg/day for (A), 0.9 (0.5-1.3) g/kg/day for (B), and 1.0 (0.6-1.3) g/kg/day for (C). Oil was gently massaged into available areas which included the head, upper arms, legs, and buttocks, over 3-4 minutes. Rubber gloves were worn when applying the oil to reduce absorption through the hands.

A total of 200 µl of heparinised blood was collected from arterial lines or from heel prick for measurement of linoleic acid and eicosatrienoic acid the endogenously produced fatty acid. Results are expressed as percentage of the total fatty acids. EFA deficiency is defined as linoleic acid concentrations below, and eicosatrienoic acid concentrations above, the normal range. Blood was collected, daily when possible, depending on whether it was being taken for routine tests. The nutritional management and fatty acid analysis methods have been described previously.⁷ The experimental protocol was approved by the Committee on Clinical Investigations at Flinders Medical Centre, and informed parental consent was obtained.

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Birth weight, gestational age, and topical oil treatment of three matched pairs of premature infants

Pair	Birth weight (g)	Gestational age (weeks)	Days oil applied	Day IV lipid introduced
(A) 1	732	26	8	11
2	955	26	0	9
(B) 1	1310	30	5 (6-10)	10
2	1140	29	0	6
(C) 1	1740	33	4	5
2	1874	31	0	5

IV, intravenous.

Linoleic acid and eicosatrienoic acid concentrations in plasma of three pairs of parentally fed preterm infants before the introduction of parenteral lipid. (A)=birth weight <1000 g, (B)=birth weight 1000–1500 g, (C)=birth weight >1500 g. Topical oil was applied to the treated group. The dotted lines represent the range of plasma fatty acid values found in 11 healthy preterm infants fed enterally from birth with at least 50% of energy coming from breast milk.

Results

The figure shows the concentrations of linoleic and eicosatrienoic acid in the six infants. The day that intravenous lipid was commenced was decided by the clinician and was independent of the investigation. All infants developed biochemical EFA deficiency during the period of fat free parenteral nutrition. The plasma fatty acid profiles of matched preterm infants, with or without topical oil application, were similar. Plasma fatty acid concentrations returned to normal once parenteral lipid was introduced (data not shown).

Discussion

Topical application of vegetable oil was not effective in preventing biochemical EFA deficiency in parenterally fed preterm infants. Reports of previous studies and anecdotal case reports on the effectiveness of topical oil application in infant populations are contradictory.^{8–12} Two previous studies reported results suggesting that oil could be absorbed.^{9,11} Even though our patients were preterm and under 2 weeks of age, both factors increasing the permeability of skin, we found no evidence to suggest that transcutaneous administration of EFA, either as triglyceride or as ethyl esters, has a role in the nutritional management of preterm infants. The physicochemical properties of these oils, which are non-polar and thus only lipid soluble, are not conducive to transdermal transfer. Agents possessing both water and lipid solubilities may be more favourably absorbed,¹³ but the difficulties of the limited area available for oil application owing to the presence of many monitors and catheters, in addition to the disturbance to the unstable infant by handling, makes the success of such an approach unlikely.

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