Transcutaneous Absorption of Topically Massaged Oil in Neonates

Kirti Solanki, Manoj Matnani, [+]Mrudula Kale, [+]Kalpana Joshi, Ashish Bavdekar, Sheila Bhave and Anand Pandit

*From the *Department of Pediatrics, KEM Hospital, Pune 411 011, India and [+]School of Health Sciences, University of Pune, Pune 411 007, India.*

Address for Correspondence : Dr. Sheila Bhave, Department of Pediatrics, KEM Hospital, Pune 411 011, India.
E-mail: kemhrc@vsnl.com

Objective: *To study the transcutaneous absorption of traditionally massaged oil in newborns and to specifically compare the effects of (i) essential fatty acid (EFA) rich - safflower oil and (ii) saturated fat rich coconut oil, on fatty acid profiles of massaged babies.* ***Design:*** *A short term randomised controlled study.* ***Setting:*** *Tertiary care NICU of a large teaching hospital and a research laboratory of a University complex.* ***Methods:*** *120 study babies were randomly assigned to three oil groups (i) safflower oil (n = 40) (ii) coconut oil (n = 40) and (iii) no oil controls (n = 40). In each group, babies were selected in three subsets as per their gestational ages viz., (a) <34weeks, (b) 34-37 weeks, (c) > 37 weeks. 5 mL of the designated oil was massaged four times a day (6hrly) for five days under controlled conditions of temperature and feeding. Pre and post oil massage samples of blood were analysed for triglycerides and fatty acid profiles using gas chromatography.* ***Results:*** *Post oil triglyceride values were significantly raised in both the oil groups and also in controls. However, the quantum of rise was significantly higher in oil groups as compared to controls (p <0.05). Fatty acid profiles (gas chromatography) showed significant rise in EFAs (linolenic acid and arachidonic acid) in safflower oil group and saturated fats in coconut oil group (p <0.05). Changes were more evident in term babies. There were no side effects associated with the massage.* ***Conclusion:*** *This study shows that topically applied oil can be absorbed in neonates and is probably available for nutritional purposes. The fatty acid constituents of the oil can influence the changes in the fatty acid profiles of the massaged babies.*

Key words: *Fatty acid profile, Topical absorption, Traditional oil .*

Massaging neonates and infants has been an important component of infant rearing in many traditions, especially in India. However, while the practice has been in place for decades, its scientific basis remains uncertain. There is also a lack of uniformity on the type of oil used for infant massage which appears to be region specific. Information on intact absorption of topically applied oil through skin and influence of neonate's gestation and type of oil used on absorption are either scanty or non-available.

Body oils can be classified as essential fatty acid rich (*e.g.*, Safflower oil) and saturated fatty acid rich oil (*e.g.*, coconut oil)(1). Coconut oil is especially rich in medium chain triglycerides (MCT), which are known to have different absorptive mechanisms from the gut and are said to be easily metabolised in the body(2). In fact, MCT oils are better metabolized than LCT oils even when given parenterally(3).

The specific objective of this study, was to study the transcutaneous absorption of massaged oil in newborns and to specifically compare the effects of (*i*) essential fatty acid (EFA) rich - safflower oil and (*ii*) saturated fat rich coconut oil, on fatty acid profiles of massaged babies.

Methods

The study was carried out in the Neonatal Intensive Care Unit of a tertiary hospital providing Level III care for neonates. Babies were randomly assigned to one of the three following groups, in order to study 40 babies in each group (Total n = 120) (*i*) Safflower oil (Saffola, Marico Industries). (*ii*) Coconut oil (Parachute, Marico Industries) (iii) Control (no oil). As fatty acid analysis by gas chromatography is an expensive and time consuming process and in view of the fund allocation we studied 120 babies only. In each group, babies were further stratified as per their gestational age in three sub-sets *viz*., (*a*) gestational age <34 weeks, (*b*) gestational age 34-37 weeks, (*c*) gestational age >37 weeks. All babies who were hemodynamically stable by third day of life and whose parents were willing to give consent were included in the study. Babies on ventilator, on parentral nutrition, with skin infection and any congenital anomaly were excluded. A computer based random number generator was used to randomize babies at an individual level using a fixed randomization technique with equal allocation of babies to each of the three categories. The investigators were blinded to the randomization sequence.

Oil application: Five mL of the study oil was massaged on all available surfaces of the baby four times a day. The massage took place for approximately 10 minutes each time by a trained massager. Rubber gloves were used and the baby was placed on a bubble wrap plastic sheet (to avoid absorption of the oil by the sheets). Such applications were continued for 5 days. A detailed general and systemic examination (including anthropometry) was performed prior to the application of the oil. A detailed feeding history was noted. All babies were clinically monitored throughout the study.

Lab estimation: Two mL of blood was withdrawn aseptically from the baby 2 hours post-feed. First sample was taken before the process of starting oil application and labeled as 'pre-oil sample' and second sample was taken at the end of 5 days, *i.e*., after the completion of oil application and labeled as 'post oil sample'. The venepuncture site was first cleaned with a fat solvent so as to prevent the contamination of the needle with the oil. The laboratory was blinded to both–pre and post sample and the massage oil category. The serum was separated into 2 parts. One part was immediately used to estimate (*a*) Serum triglycerides(4) while the second part was stored at temperature of –20ºC. These samples were transported in batches to School of Health Sciences, Pune. for estimation of (*b*) Fatty acid profiles by gas chromatography (5) which includes (*i*) Linoleic acid (LA), (*ii*) Arachidonic acid (AA), (*iii*) Alpha Linolenic acid (ALA), (*iv*) Docosa-hexaenoic acid (DHA) (v) Total saturated fats (TSF), (*vi*) Other fats (OF).

During the five days of massage, the babies were monitored for adverse effects of oil application in the form of skin rashes (erythema toxicum, dermatitis *etc*.,) as also for generalized adverse effects.

Data analysis was done using SPSS version 8.0. The fatty acid measurements had skewed distributions. The values were transformed to normality using logarithms. The differences in the triglycerides and fatty acid levels (pre and post oil) for the three groups separately were analysed by the paired 't' test. The quantum of change in triglycerides and fatty acids (pre- and post oil) in the 3 groups was calculated as proportionate change from basal value (proportionate change = post oil value / pre oil value). These values were also skewed and had to be log transformed. The proportionate change in the fatty acids in

the two oil groups were compared with the controls by student 't' test.

The study was approved by the hospital ethical committee and informed consent was obtained from the parents of the babies studied.

Results

One hundred and twenty neonates (40 in each group) were included in the study. Two babies of the original 120 developed medical complications on 2nd and 3rd day respectively (not related to oil) and were excluded from further study. There were 71 males and 47 females. There were 42 babies (35%) with GA <34 weeks, 30 babies (25%) with GA 34-37 weeks and 46 full term babies (40%) (*Table I*). Their birthweights ranged from 980-3442g Babies were recruited when stable (1-3 days).

The change in serum fatty acids and triglycerides before and after oil application for the three groups is shown in *Table II.* The safflower group showed significant rise in triglycerides, Linoleic acid (LA) and Arachidonic acid (AA) whereas coconut oil group significant rise in triglycerides and Total Saturated Fats (TSF) in the coconut oil group. Control group also showed significant rise in triglycerides, TSF and LA.

Since the rise in some fatty acids after oil application was also seen in controls, the quantum of increase was calculated (see methods) and the proportionate change in the various serum fatty acid levels for the two oil groups were compared with the controls (*Fig. 1*). The safflower oil group had significantly higher triglyceride and LA levels as compared to controls while the coconut oil group had significantly higher triglyceride and TSFs. This rise in the proportionate change in fatty acids after oil applications of both safflower and coconut oils was seen in the term babies only and not in preterm babies (*Table III*).

Three babies who were applied safflower oil developed a transient papular skin rash over the abdomen on the 3rd and 4th day. In all these babies the rash disappeared within a day or two inspite of continuing oil massage. There were no other side-effects observed in any of the babies.

Discussion

In this study, newborns of different gestational ages were massaged with two different oils, namely, (*i*) Essential fatty acid rich safflower oil and (*ii*) Saturated rich coconut oil. Control babies in each gestational age group had no oil application. Serum triglycerides and fatty acid profiles (using Gas Chromatography) were estimated before and after 5 days of oil application, under controlled condition in our NICU. We found a significant rise in triglycerides in the both the oil application groups, as well as controls. However, the quantum of rise was much higher in the oil groups as compared to controls. Importantly, essential fatty acids LA and AA were raised in safflower group whereas, saturated fats were increased in coconut oil group which corresponds to the fatty acid constituents of the oils concerned. This study therefore, conclusively demonstrates two important aspects (*a*) that massaged oil can be absorbed percutaneously to significant degrees in the newborn, and (*b*) the types of oil used can alter the lipid profile of the baby.

The clinical implications of these findings are many, the most important being the therapeutic value of the massaged oil. Friedman, *et al.*(6) and Miller, *et al.*(7) demonstrated the use of topical application of safflower oil to treat babies with essential fatty acid deficiency. Both the studies however, were conducted on sick newborns who

TABLE I –*Clinical Characteristics of the Three Study Groups.*

	Safflower oil group	Coconut oil group	Control (no oil)
N	39	40	39
Male/Female	21/18	27/13	23/16
Birth weight (g)			
Mean (SD)	2078.90 (561.9)	1938.35 (588.7)	1991.24 (590.2)
Range	(1065-3300)	(980-3442)	(1000-3400)
Gest. age (wks)			
Mean (SD)	35.23 (2.8)	35.22 (2.9)	35.22 (3.1)
<34 wks (n)	13	14	15
34-37 wks (n)	14	11	5
>37 wks (n)	12	15	19
AGA / SGA	29/10	31/9	31/8
Age at (days) inclusion in study			
Mean (SD)	1.54 (0.7)	1.53 (0.7) (1-4)	1.56 (0.8)
Range	(1-3)	(1-4)	(1-4)

showed rapid reversal of clinical and biochemical manifestations of EFA deficiency. On the other hand, some anecdotal reports have failed to show any use of topical oil in prevention or therapy of EFA deficiency (8-10). However, EFA acids are now available in parenteral lipid presentations and by and large oil massage is no longer used in the West for such therapeutic measures.

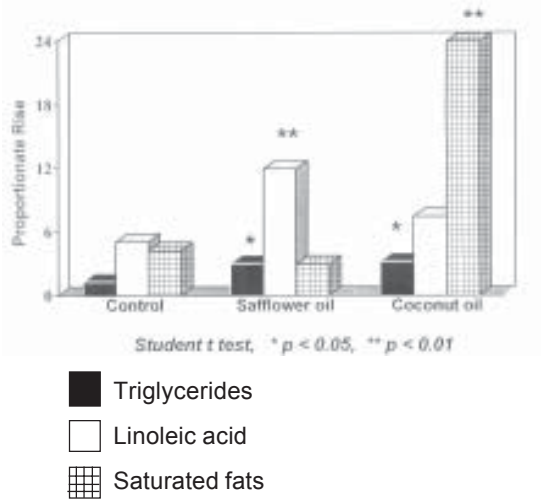

Fig. 1. Proportionate rise in fatty acids from baseline in the oil groups compared to the controls.

But the situation is different in our country. Parenteral lipids (and parenteral nutrition) is generally beyond the means of the 'common' newborn (economically and technically). Yet neonates in our country especially the preterm and LBW babies would be benefited greatly by an additional source of calories and EFAs, especially if the 'source' is as easy and non invasive as an oil massage. Though breast feeding is more or less universal in our country, extra nutrients are often needed for the sick and small LBW babies because of limited capacity of the stomach and immaturity of fat metabolism. Though our studies could not ratify this finding, prematures are said to absorb oil better because of increased vascularity and permeability of their skin(11). Our studies and

TABLE II –*Change in serum fatty acid levels (pre & post oil) for the three groups.*

Lipids	Safflower oil (n = 39)		Coconut oil (n = 40)		Control (n = 39)	
	Pre oil	Post oil	Pre oil	Post oil	Pre oil	Post oil
TG	95.4 (44.92)	167.11 (79.05)***	78.76 (43.46)	157.8 (65.96)***	107.93(67.12)	136.3 (58.45)*
LA	1.0 (1.0-4.1)	5.0 (1.0-13.4)***	1.25 (1.00-8.67)	6.3 (1.00-11.10)	1.3 (1.0-3.63)	4.8 (1.0-22.05)*
AA	1.10 (1.0-7.5)	8.2 (1.0-16.8)***	4.20 (1.275-14.80)	6.65 (1.12-10.15)	1.6 (1.0-7.6)	2.40 (1.0-16.6)--
ALA	1.2 (1.0-9.2)	2.8 (1.0-9.3)	4.90 (1.0-12.225)	3.90 (1.10-9.70)	1.0 (1.0-10.35)	3.30 (1.0-17.65)
DHA	1.0 (1.0-5.0)	1.0 (1.0-5.2)	1.55 (1.00-5.85)	1.00 (1.00-5.40)	1.10(1.00-6.6)	1.00 (1.00-5.7)
TSF	8.0 (3.0-17.2)	7.4 (1.0-39.8)	12.15 (3.47-37.92)	26.55 (10.87-301.55)***	7.5 (2.5-41.55)	27.7 (2.7-75.5)*
OF	1.0 (1.0-1.85)	1.0 (1.0-4.8)	1.00 (1.00-7.50)	1.00(1.00-22.4)	1.0 (1.0-18.15)	1.0 (1.0-21.7)

Triglycerides expressed as mg/dl, All other fatty acids expressed as µg/dL.

Values for TG expressed as Mean (SD); Values for all others expressed as Median (inter quartile range).

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

TG - Triglycerides; LA- Linoleic acid

ALA- Alpha Linolenic acid; AA- Arachidonic acid

DHA- Docosa-hexaenoic acid; TSF- Total saturated fats

OF - Other fats

others have shown that massaged oil can be absorbed to a significant degree in neonates (12). Soriano, *et al.* have demonstrated a significant increase in somatic growth in preterms in four weeks of oil application(13). However, no studies to date have been directed towards determining the exact proportion of oil absorption or towards its metabolic fate in the long range. Obviously, sophisticated studies such as radio-isotopic labeling or DEXA are required to further answer this question.

There are many other recorded advantages of oil massage in babies. Fernandez, *et al*. in an elegant study in Mumbai demonstrated the value of oil massage in thremoregulation of small preterm babies(14). It was suggested that oil application conserves internal body heat probably by reducing insensible water losses thereby, proving useful in community

TABLE III–*Proportionate Change in Fatty acids in the Two Oil Groups.*

Lipids	Safflower oil		Coconut oil		Control (No oil)	
	< 37 wks	> 37 wks	< 37 wks	> 37 wks	< 37 wks	> 37 wks
	n = 27	n = 12	n = 25	n = 15	n = 20	n = 19
Triglycerides	1.89	2.19*	2.1	1.96	1.46	1.53
	(0.84)	(0.92)	(0.8)	(0.93)	(0.86)	(0.59)
LA	1.36	5.96 *	1.06	1.44	1.11	1.0
	(1.00-7.7)	(1.0-16.36)	(0.77-3.49)	(1.0-11.1)	(1.0-3.33)	(0.90-3.66)
AA	1.68	1.81.2	1.11	1.4	1.1	
	(1.0-9.4)	(0.69-18.47)	(0.44-2.52)	(0.66-6.63)	(0.77-15.35)	(0.56-1.20)
ALA	1.04	2.85	1.6	0.35	1.84	1.2
	(0.28-1.25)	(1.0-15.22)	(0.29-4.12)	(0.15-1.0)	(0.73-3.60)	(0.46-5.14)
DHA	1.04	1.00	1.02	1.02	0.7	1.1
	(0.78-2.3)	(0.50-1.70)	(0.64-1.24)	(0.53-1.41)	(0.56-1.07)	(0.80-1.69)
TSF	0.84	1.03	3.03	8.44 **	1.73	0.9
	(0.20-2.0)	(0.53-6.35)	(0.79-7.88)	(1.76-28.50)	(1.0-8.07)	1(0.38-5.58)
Other fats	1.02	1.08	1.00	0.9	1.2	1.1
	(0.61-1.3)	(1.0-5.25)	(1.0-1.57)	(.0.7-1.24)	(0.81-3.06)	(0.87-1.90)

Values for TG expressed as Mean (SD); Values for all others expressed as Median (inter quartile range).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
LA - Linoleic acid AA- Arachidonic acid
ALA - Alpha Linolenic acid DHA- Docosa-hexaenoic acid
TSF- Total saturated fats

Key Messages

- Topically massaged oil is absorbed significantly in neonates.
- The composition of the oil used can influence the fatty acid profiles of the massaged babies.

management of low birth weight babies. Our study was conducted under controlled thermal conditions (servo-controlled) and hence we are not in a position to comment on this aspect. So also, the advantages of human bonding and environmental stimulation which would come automatically with massage are obvious but hard to measure(15).

In conclusion, topical application of oil to neonates can alter their lipid profiles quantitatively and qualitatively (depending on the constitution of the oil). However, their therapeutic benefits need confirmation by further studies.

Acknowledgements

Acknowledgement is made to Dr. S.S. Naik for carrying out the Biochemical assays and to Mr. Ashok Vairagar and Ms. Anjali Biswas for assistance in data collection and patient care. Grateful acknowledgement is also made to Heinz Nutrition Foundation India (HNFI), Chennai for funding the study.

Contributors: KS and MM were involved in clinical data collection and provided day to day supervision of the study. MK and KJ carried out the fatty acid estimations. AB and SB were responsible for co-ordination of the study, statistical analyses and drafting the paper. AP conceived and supervised all aspects of the study. SB will act as guarantor for the manuscript.

Funding: Heinz Nutrition Foundation India (HNFI), Chennai.

Competing interests: None stated.

REFERENCES

1. Cottrell RC. Nutritional aspects of palm oil. Am J Clin Nutr 1991:53:989S-1009S.
2. Vaidya UV, Hegde VM, Bhave SA, Pandit AN. Vegetable oil fortified feeds in the nutrition of very low birth weight babies. Indian Pediatr 1992; 29: 1519-1527.
3. Dennison AR, Ball M, Crowe PJ, White K, Hands L, Watkins RM, *et al*. The metabolic consequences of infusing emulsions containing medium chain triglycerides for parenteral nutrition: A comparative study with conventional lipid. Ann R Coll Surg Engl 1986; 68: 119-121.
4. Warnick GR. Enzymatic methods for quantification of lipoprotein lipids. Methods Enzymol. 1986; 129: 101-123.
5. Manku MS, Horrobin DF, Huang YA, Morse N. Fatty acids in plasma and red cell membrane in normal human. Lipids 1983; 18: 906-908.
6. Friedman Z, Shochat SJ, Maisels MJ, Marks KH, Lamberth EL. Correction of essential fatty acid deficiency in newborn infants by cutaneous application of sunflower-seed oil. Pediatrics 1976; 5895: 650-654.
7. Miller DG, Williams SM, Palombo JD, Griffin RE, Bistrain BR Blockburn GL. Cutaneous application of safflower oil in preventing essential fatty acid deficiency in patients on home parenteral nutrition. Am J Clin Nutr 1987; 46: 419-423.
8. Hunt CE, Engel RR, Modler S, Hamilton W, Bissen S, Holman RT. Essential fatty acid deficiency in neonates: inability to reverse deficiency by topical applications of EFA-rich oil. Pediatrics 1978; 92: 603-607.
9. Lee EJ, Gibson RA, Simmer K. Trans-cutaneous application of oil and prevention of essential fatty acid deficiency in preterm infants. Arch Dis Child 1993; 68: 27-28.
10. Sacks GS, Brown RO, Collier P, Kudak KA.

Failure of topical vegetable oils to prevent essential fatty acid deficiency in a critically ill patient receiving long-term parenteral nutrition. JPEN 1994; 18: 274-277.

11. Scheuplein RJ. Mechanism of percutaneous absorption. J Invest Dermatol 1967; 48: 79-82.

12. Fernandez AR, Krishnamoorthy G, Patil N, Mondkar JA, Swar BD. Transcutaneous absorption of oil in preterm babies - A pilot study. Indian Pediatr 2005; 42: 255-258.

13. Soriano CR, Martinez FE, Jorge SM. Cutaneous application of vegetable oil as a coadjutant in the nutritional management of preterm infants. J Pediatr Gasterol Nutr 2000; 31: 387- 390.

14. Fernandez A, Patkar S, Chawla C, Taskar T, Prabhu SV. Oil application in preterm babies - A source of warmth and nutrition. Indian Pediatr 1987; 24: 1111-1116.

15. Acolet D, Modi N. Giannakoulopoulos X, Bond C, Weg W, Clow A, *et al*. Changes in plasma cortisol and catecholamine concentration in response to massage in preterm infants. Arch Dis Child 1993; 68: 29-31.