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HUMAN MILK: RELATIONSHIP OF FAT CONTENT WITH GESTATIONAL AGE

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SUMMARY

In order to assess the suitability of early human milk as a food for preterm infants, concentrations of fat were analyzed in milk samples representative of complete 24-h expressions, obtained serially over the first 30 days of lactation from 47 mothers delivering at term (FT) and 25 mothers delivering prematurely (PT).

During the first postpartum month milk fat increased with progressing lactation both in FT and PT mothers' group. The increase was significant over the first 10 day period. During this stage the fat content was significantly higher in the milk from PT mothers than in FT mothers. A significant inverse correlation of fat content with gestational age was established.

On the basis of these results, the higher energy intake obtained with PT milk suggests that it may be reasonable to prefer the use of mothers' own early milk than pooled milk as the more appropriate feeding for premature infants.

human milk; milk fat; premature infant nutrition

INTRODUCTION

The increasing survival rate of even the smallest preterm infants, together with the realization that appropriate early nutrition may be one of the major contributing factors for later wellbeing, has lead many authors critically to re-evaluate current feeding principles for preterm infants, especially with

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regard to the suitability of human milk to meet the nutritional requirements for the growing premature infant [5,8,10,17,18].

Since many immunological and nutritional benefits of human milk, such as the protective role against neonatal sepsis [12] and necrotising enterocolitis [4,19], the digestibility of the fat [9] and the specific composition of protein [11,20,23] are generally accepted, pooled human breast milk continues to be widely recommended even if it seems, for reasons poorly understood, not to allow adequate early postnatal growth [6,10,21].

It has been suggested that pooled, mature human milk does not provide adequate quantities of protein and minerals to meet the predicted requirements for the growing premature infant [8,10]. Although mature milk may be inappropriate, the nutritional adequacy of human milk produced during the first few weeks postpartum remains to be assessed. Similarly, little else is known about the nutrient composition of milk from mothers giving birth prematurely.

Recently, several authors reported greater concentrations of nitrogen and minerals in the milk of women delivering prematurely than in that of those delivering at term [1,3,13,22]. These data could suggest that the chemical composition of milk is related to gestational age.

Less is known about fat content during early lactation of mothers delivering preterm, and data recently reported by Gross et al. [13] and by Atkinson et al. are contradictory [2,3].

The purpose of the present study was to determine fat concentrations over the first 4 weeks of lactation in milk from mothers delivering at different gestational ages in order to assess any relationship between fat content and duration of pregnancy.

In this report we show that, over the first month of lactation, fat concentration is higher in milk from mothers given birth prematurely than in milk from those giving birth at term; and that during the 2—10 day stage there is an inverse relation between fat content and gestational age.

MATERIALS AND METHODS

Two hundred complete 24-h collections of milk were obtained on postpartum days 2, 3, 4, 5, 6, 10 and 30 from 72 mothers who had given verbal consent following explanation of the study protocol.

123 collections were obtained from 47 mothers giving birth at 38—42 (39.6 ± 1.0) weeks of gestation, and 77 collections were obtained from 25 mothers giving birth at 29—37 (33.3 ± 2.2) weeks of gestation. There were three sets of twins in the term group and two in the preterm one. 55 infants (24 preterm, 31 at term) were appropriate for gestational age (AGA), 22 (3 preterm, 19 at term) were small for gestational age (SGA). Small for gestational age were considered infants whose birth weight resulted below the 10th percentile of the intrauterine growth standards assessed for our area [14].

Milk was expressed by mothers manually or by breast pump, emptying both breasts 4—6 times daily. Milk was collected in sterile bottles and the complete 24-h volume measured. Aliquots representative of pooled 24-h expressions were stored at —20° C for analysis.

Fat content was determined on duplicate samples according to the modified De la Huerga method (lipids extracted from milk in an acid solution containing ethylenedioxide, produce a turbidity that can be determined photometrically) (Lipids Kit, Chemetron, Milano, Italy).

Statistical evaluation of collected data was performed by Student's *t*-test and linear regression analysis.

RESULTS

The concentration of milk fat over the 2—30 day postpartum period increased with progressing lactation in both the FT and PT group. The lowest concentrations of fat were found on postpartum day 3 and averaged 2.262 (±1.031) g/dl in PT milk and 1.456 (±0.509) in FT milk. With progressing lactation, fat content increased in both groups, reaching average concentrations on day 30 of 3.497 (±0.857) g/dl in PT milk and 2.995 (±0.546) in FT milk (Table I).

The mean concentrations of fat were significantly higher in PT milk on day 2, 3, 4, 5, 6 and 10. No significant difference was found on day 30 of lactation.

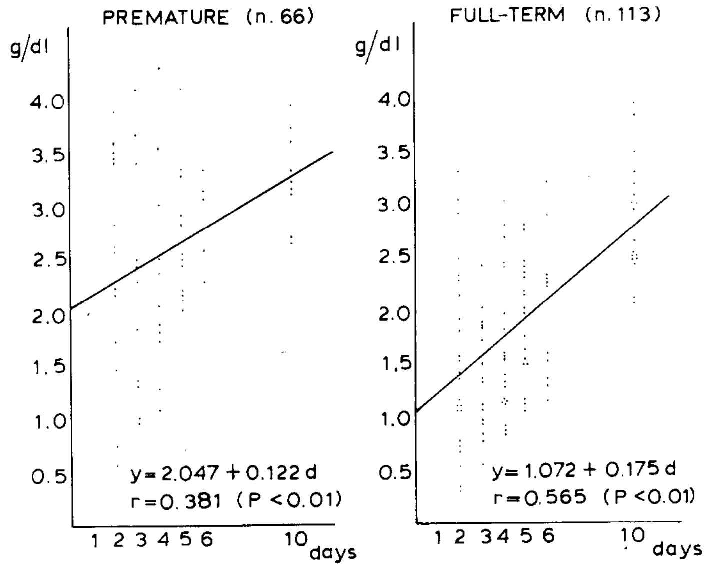

Fig. 1. The relationship of fat concentration in milk to day of lactation. Analysis was performed to define regression lines for fullterm and for premature neonates. Regression equations are shown.

TABLE I

Fat content of milk from mothers delivering preterm and at term

Days	2	3	4	5	6	10	30
PT							
$\bar{x}$	2.487 ± 1.031	2.262 ± 1.051	2.458 ± 0.891	2.550 ± 0.441	2.880 ± 0.400	3.303 ± 0.368	3.497 ± 0.857
n	(14)	(11)	(10)	(11)	(5)	(13)	(13)
FT							
$\bar{x}$	1.608 ± 0.862	1.456 ± 0.509	1.673 ± 0.668	1.948 ± 0.514	2.044 ± 0.624	2.898 ± 0.532	2.995 ± 0.546
n	(26)	(18)	(20)	(19)	(12)	(18)	(10)
t	2.612	2.461	2.422	2.793	2.229	2.179	1.531
(P)	<0.05	<0.05	<0.05	<0.01	<0.05	<0.05	ns
r	0.515	0.431	0.361	0.343	0.787	0.439	0.210
(P)	<0.001	<0.05	<0.05	<0.05	<0.001	<0.05	ns

Days: postpartum days. PT: preterm. FT: fullterm. Results are expressed as mean (g/dl) ± SD with the number of pools in parentheses. t: Student's t-test. r: correlation coefficient between fat concentrations and gestational ages.

TABLE II

Fat content of milk from mothers delivering at term: AGA and SGA newborns *

Days	2	3–4	5–6	10	30
AGA					
$\bar{x}$	1.671 ± 0.805	1.499 ± 0.649	2.012 ± 0.629	2.637 ± 0.383	2.754 ± 0.552
n	(20)	(19)	(16)	(9)	(5)
SGA					
$\bar{x}$	1.395 ± 1.002	1.642 ± 0.553	1.951 ± 0.475	3.160 ± 0.533	3.235 ± 0.418
n	(6)	(19)	(15)	(9)	(5)
t	0.687	0.727	0.481	0.850	1.393
(P)	ns	ns	ns	ns	ns

* In the PT group only 1 newborn was SGA.
ns, not significant.

TABLE III

Fat content of milk from mothers delivering AGA newborns preterm and at term

Days	2	3–4	5–6	10	30
PT					
$\bar{x}$	2.566 ± 1.028	2.225 ± 1.002	2.606 ± 0.431	3.236 ± 0.361	3.268 ± 0.237
n	(13)	(20)	(15)	(11)	(10)
FT					
$\bar{x}$	1.671 ± 0.805	1.499 ± 0.649	2.012 ± 0.629	2.637 ± 0.383	2.754 ± 0.552
n	(20)	(19)	(16)	(9)	(5)
t	2.512	2.455	2.663	2.799	2.114
(P)	<0.05	<0.05	<0.05	<0.05	ns

ns, not significant.

Linear regression analysis of the data demonstrated that over the first 10 days, fat concentration increased significantly with progressing lactation at a similar rate in both groups (the slopes were not significantly different) (Fig. 1). The y-intercepts of 2.047 g/dl and 1.072 g/dl for the PT and FT groups, respectively, were different ($P < 0.001$), thus the increase in fat concentration with time was similar in the two groups but the PT milk had a significantly higher fat content than the FT milk during the first 10 days of lactation.

On the basis of this difference we have analysed the fat content in relation to the gestational age. Over the stage in which the mean concentrations were significantly different in FT and PT groups, an inverse correlation coefficient between fat concentrations and gestational ages was also significant (Table I).

To investigate a possible relationship between milk fat content and weight for gestational age at birth, we compared milk from mothers delivering AGA neonates with milk from mothers delivering SGA neonates (Table II). In neither group of FT and PT mothers was there any difference found between mean fat concentrations of milk from mothers delivering AGA or SGA neonates. Considering only mothers delivering AGA neonates, the correlation between milk fat concentrations and gestational ages did not change, except on day 30 of lactation (Table III).

No correlation was found either between fat concentrations and daily milk amounts or between fat concentrations and birthweights (expressed as percentile values of the fetal growth standards assessed for our area) [14].

DISCUSSION

The results reported here indicate that in the first month postpartum milk fat increases with progressing lactation. The increase is significant over the first 10 day period. During this stage, the fat content is significantly higher in the milk from mothers delivering preterm than in milk from mothers delivering at term and a significant inverse correlation of fat content with gestational age has been established.

Our results differ from those recently reported by Gross et al. [13] who did not find significant differences in fat content of milk from FT and PT mothers. These authors determined fat content on single samples collected in the morning. Because, as previously reported [15,16], we also found marked diurnal variations of the fat content, we assumed determinations made on samples obtained by complete 24-h expressions were more representative than determinations made on single collections. In our opinion, this different methodology may at least partly account for the discrepancy with the results reported by Gross et al. [13].

Atkinson et al. [2], by using complete 24-h collections, found results quite similar to ours and reported a 35% higher fat concentration in PT milk during early lactation.

The milk fat content does not differ between mothers delivering SGA or

AGA neonates of similar gestational age. This suggests that the mammary glands of mothers delivering SGA neonates are normally functioning and undergo postpartum maturation processes as do the mammary glands of mothers delivering AGA neonates. Lactation therefore would not be related to the factors responsible of intrauterine growth retardation.

In summary, our results, in agreement with the previous report of Atkinson et al. [2], confirm that over the first 10 days postpartum the fat concentration of human milk increases with progressing lactation and is higher in expressed PT milk than in FT milk. Thus early PT milk, in addition to being higher in protein and minerals content [1,3,13,22] would also be higher in energy content than FT milk.

The inverse correlation of the fat content with the gestational age raises the possibility that milk from women who deliver prematurely may be uniquely suited to meeting the nutritional needs of their infants; and this would therefore confirm the suitability of mother's own early milk rather than pooled milk as the more appropriate feed for premature infants.

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