Brief Reports

Effect of Fortification with Human Milk Fortifier (HMF) and other Fortifying Agents on the Osmolality of preterm Breast Milk

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This study was conducted to test the effect of fortification with human milk fortifier (HMF), low birth weight (LBW) formula and coconut oil, initially and upon subsequent storage, on the osmolality of preterm breast milk. Milk samples (n = 48) were collected from mothers (n = 25) delivered at £ 34 weeks and fortified with HMF (Lactodex-HMF), LBW formula (Lactodex-LBW) and edible coconut oil. Osmolality was measured before and after fortification and after 6 hours,.The gestation and birth weight (median) was 31 (range 29-32) weeks and 1198 (range 716-1478) grams. The median (range) postnatal age at testing was 15 days (range 3-60 days). There was a significant increase in osmolality of breast milk (302.3 ± l.82) after addition of HMF (392.9 ± 3.01) and LBW formula (390.5 ± 2.4). There was no change in osmolality with addition of coconut oil (304 ± 1.6). There was no further change in the osmolality after 6 hours of storage at 4ºC.

Key words: *Coconut oil, Fortification, Human milk fortifier (HMF), LBW formula, Osmolality.*

Human milk feeding has been shown to be of enormous advantages in preterm infant(1-3). Few studies have observed that human milk-fed preterm infants have slower growth rate and inadequate specific nutrient intake to meet their proportionately greater needs(1,4). Fortification of human milk has been therefore recommended. Human milk fortifier (HMF) has been available in India since late nineties but its safety and efficacy has still not been established. Other means of fortification include LBW formula and coconut oil. Fortification can result in increase in milk osmolality(5-6), which may be associated with adverse effects such as feed intolerance and necrotizing enterocolitis(7-8).The present study evaluated the effect of fortification with HMF, LBW formula and coconut oil on the osmolality of preterm breast milk.

Subjects and Methods

It was a prospective, blinded study conducted at a tertiary care institute enrolling women delivered before or at 34 weeks. Written informed consent was taken. Milk was expressed manually or using electric breast pump.

Fortification of breast milk was done with Human Milk Fortifier (Lactodex-HMF; Raptakos, Brett and Co. Ltd.; 4 g/100 mL of milk), LBW formula (Raptakos, Brett and Co. Ltd; 4 g/100 mL) and edible coconut oil (2 mL/100 mL). A comparison of the various compositions is provided in *Table I*.

Osmolality was measured by Advanced™ Micro-Osmometer, model 3300 (Advanced Instruments Inc, MA USA) by a technician blinded to fortification. The equipment works on the principle of freezing point measurement with precision of 2 mOsm/Kg. The osmolality of fortifying agents dissolved in water at the same concentration as used for fortification (O_{FW}) was measured. By adding measured osmolality of milk and O_{FW}, expected rise in osmolality of milk on fortification was calculated. Milk osmolality was measured after fortification at 20 minutes and at 6 hrs (after storing at 4ºC). To detect a difference of 20 mOsm/kg in milk osmolality (alpha-0.05 and beta-0.2), 40 milk samples were needed. Paired two tailed Student t-test was applied.

Results

Forty eight milk samples were tested from 25 mothers (multiple samples from 14 mothers at different postnatal age). The demographic details are provided in *Table II*.

The osmolality of breast milk with and without fortification is provided in *Table I*. There was no change in osmolality of breast milk after storage for 6 h. The fortification of breast milk with HMF and LBW formula resulted in significant rise in osmolality ($P < 0.0001$). However, no further change in osmolality was observed on storage for 6 h. Addition of coconut oil did not make any significant difference in osmolality at 20 min and after 6 h of storage.

The observed osmolality change with

TABLE I–*Composition and Osmolality of Breast Milk (per 100 mL) with and without Fortification*

Ingredients	Breast milk	Breast milk + HMF* (4 g/100 mL)	Breast milk + LBW formula† (4 g/100 mL)	Breast milk + coconut oil‡ (2 mL/100 mL)
Calories	65	78	81	83
Proteins (g)	1.6	2	2.1	1.6
Carbohydrates (g)	7	9.4	9.2	7
Fat (g)	4	4.2	5	6
Calcium (mg)	40	140	72	40
Phosphorus (mg)	20	70	36	20
Vitamin A (IU)	250	1700	310	250
Vitamin D (IU)	2.5	500	22.5	2.5
Sodium (mEq)	0.8	1.6	1.3	0.8
Iron (mcg)	300	300	500	300
Folate (mg)	5	6	17	5
Osmolality at 20 minutes (mOsm/kg)	302.3 ± 1.82	392.9 ± 3.01	390.5 ± 2.4	304 ± 1.6
Osmolality after 6 hr mOsm/kg)	301 ± 1.75	393.3 ± 3.0	390.7 ± 2.3	303.6 ± 1.6

* HMF (Human Milk Fortifier): All components except sodium meet the nutritional requirement.
† LBW formula: Calcium, phosphorus, sodium inadequate; calories adequate.
‡ Coconut oil: Only the calorie content is increased.

TABLE II–*Demographic Characteristics of Study Population*

Maternal details (n = 25)	
Age (range)	26 years (25-30)
Height (range)	155 cm (140-160)
Parity (range)	1 (1-3)
Delivery by LSCS (%)	17 (68%)
Pregnancy induced hypertension (%)	9 (36.1)
Anemia (%)	8 (32%)
Neonatal details (n = 25)	
Gestational age (range)	31 (29-32 wks)
Birth weight (range)	1198 g (716-1478 g)
Small for gestational age (%)	11 (42.3%)
Postnatal age at testing milk (range)	15 days (3-60 days)

addition of HMF and LBW formula was significantly higher than the expected osmolality (*Table III*). However, with coconut oil, the osmolality of breast milk remained unaltered. No further change was seen after storage for 6 hours with any of the fortifying agents.

Discussions

Our study demonstrated that osmolality of breast milk increases significantly on fortification with HMF and LBW formula. However, it remains unaltered on addition of coconut oil. The increase in osmolality was significantly higher than expected value. There was no effect of storage at 4ºC for 6 hours on the osmolality of milk.

DeCurtis, *et al*.(5) measured the effect of fortification with different HMF preparation on the osmolality of milk. Significant increase in osmolality was demonstrated on addition of HMF. The increase in osmolality depended upon composition of HMF. With a protein based HMF, increase in osmolality was equal

TABLE III–*Comparison of Observed Vs Expected Change in Osmolality* at 20 Minutes and 6 Hours.*

Fortification	Expected change* in osmolality at 20 min (Agent + water)	Observed change in osmolality at 20 min (Agent + milk)	Expected change* in osmolality at 6 hours (Agent + water)	Observed change in osmolality at 6 hours (Agent + milk)
HMF	54.9 ± 0.9	92.8 ± 2.1†	55.1 ± 0.9	92.8 ± 2.1†
LBW formula	56.6 ± 0.5	88.3 ± 2.1†	56.2 ± 0.5	88.4 ± 2†
Coconut oil	3.6 ± 0.4	1.8 ± 0.9	3.0 ± 0.4	1.4 ± 0.8

All values (mOsm/kg) expressed as mean ± standard error (range)

* Expected change in osmolality was estimated as the osmolality of the fortifying agent dissolved in water (in the same concentration used to forify breast milk)

† Comparison of expected vs observed change in osmolality, p value <0.001

Key Message

- Fortification of pre term human milk with available human milk fortifier (HMF), LBW formula results in significant increase in osmolality

to the expected value at 10 minutes with no late rise while significant increase with late rise in osmolality was noted with carbo-hydrate based HMF. Linear regression analysis showed that the total dextrin content determined increase in osmolality. Jocson, *et al.*(6) also reported early as well as late rise osmolality of breast milk with HMF forti-fication. Our results were consistent with the above studies.

The HMF and LBW formula used in present study is predominantly maltodextrin based. Higher than expected increase in osmolality could be due to breakdown of maltodextrin by amylase present in breast milk(5). The polysaccharides are broken down into smaller molecules by the amylase enzyme resulting in a higher number of osmotically active molecules. Bacterial degradation of constituents as a possible mechanism for unexpected increase in osmolality(6) seemed improbable since there was no late rise in osmolality.

Osmolality is a critical determinant of feed tolerance(5-6). Milk fortification results in significant increase in osmolality(5,6). Cochrane meta-analysis has shown an increased tendency for feed intolerance with fortified milk(7). Feed intolerance may result in the reduction in nutrient intake which can explain lower weight gain compared to formula in VLBW infants(7). An association between hyper-osmolar feeds (³400 mOsm/kg) and necrotizing enterocolitis has also been reported(8).

There is need to develop safer preparations of HMF, which can provide additional nutrients in VLBW infants. Since fat is not osmotically active, it may be preferable to use a predominantly fat based HMF. However, fat delays the gastric emptying with an attendant risk of feed intolerance and reduction in overall calorie intake resulting in no effect on growth velocity(3).

We conclude that available preparation of HMF as well as practice of supplementing human milk with LBW formula may not be safe because of significant increase in osmo-lality. There is a need to develop a safer pre-paration of HMF for VLBW population in India.

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REFERENCES

1. Schanler RJ. Suitability of human milk for the low birth weight infant. Clin Perinatol 1995; 22: 207-222.
2. Innis SM. Human milk and formula fatty acids. J Pediatr 1992; 120: S56-S61.
3. Jensen RG, Jensen GL. Specialty lipids for infant nutrition: milks and Formula. J Pediatr Gastroenterol Nutr 1992; 15: 232-245.
4. Atkinson SA, Bryan MH, Anderson GH. Human milk feeding in premature infants: Protein, fat and carbohydrate balances in the first two weeks of life. J Pediatr 1981; 99: 617-624.
5. DeCurtis M, Candusso M, Pieltain C, Rigo J.

Effect of fortification on the osmolality of human milk. Arch Dis Child Fetal Neonatal ed. 1999; 81: F 141-143.

6. Jocson MA, Mason EO, Schanler RJ. The effects of nutrient fortification and varying storage conditions on host defense properties of human milk. Pediatrics 1997; 100: 240-243.

7. Kuschel CA, Harding JE. Multicomponent fortified human milk for promoting growth in preterm infants. Cochrane Database Syst Rev 2000; 2: CD000343.

8. Book LS, Herbst J J, Atherton SO, Jung AL. Necrotizing enterocolitis in low birth infants fed an elemental formula. J Pediatr1975; 87: 602-605.

Comparison of Pediatric Emergency Patients in a Tertiary Care Hospital vs A Community Hospital

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This study was conducted to compare the profile of patients attending the pediatric emergency services of a tertiary care teaching and referral hospital, Chandigarh, and a community level hospital in Ambala district, Haryana. Records of children (≤12 years) attending emergency services over a period of one year; from 1st March 1999 to 28th February 2000, at both the health facilities were analyzed for demographic details, diagnostic categories, monthly trends of illnesses and mortality pattern. Five hundred ninety six children attended the Community Hospital's emergency service while 8301 children were seen at the pediatric emergency service of the tertiary care hospital during the same period. The most common morbidities at both the centers were diarrhea and respiratory infections (58% at community hospital, 45% at tertiary care hospital respectively). Neonatal illnesses and CNS diseases were other important morbidities. There was a significant use of emergency facilities for management of trivial complaints. At tertiary care hospital 26% of AR1 cases had upper respiratory infections, while 70% of diarrhea cases seen were without dehydration. At both the hospitals neonatal deaths formed the major proportion of all the deaths. We concluded that diarrhea and AR1 continue to be the most important reasons for utilization of pediatric emergency service at a primary as well as a tertiary care hospital.

Key words: *Community hospital, Emergency medicine, Emergency service, Intensive care.*

Epidemiological data comparing the pediatric emergency attendance and admission profile of a community hospital with a tertiary care hospital is not available. This data is necessary for evidence-based decisions by health planners to study disease epidemiology and appropriately allocate the scarce health resources in these two different types of health care facilities(1). Non-availability of trained staff, inadequate drugs and equipments and lack of triage are some of the deficiencies commonly encountered in the