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Role of Oral Medium Chain Triglyceride Oil in Low Birth Weight Neonates: A Randomized Controlled Trial

Rida Hameed[1], Aqsa Arooj Asif[1]

[1]Department of Pediatrics, Sharif Medical and Dental College / Sharif Medical City Hospital, Lahore, Punjab, Pakistan.

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Correspondence to: Rida Hameed, Postgraduate Resident, Department of Pediatrics, Sharif Medical and Dental College / Sharif Medical City Hospital, Lahore, Punjab, Pakistan.
Email: ridahameed1234@gmail.com

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ABSTRACT

Introduction: Low birth weight neonates are at increased risk of poor neurodevelopmental outcomes. Head circumference is an important anthropometric measure that correlates with brain growth and neurodevelopment. Medium chain triglycerides (MCT) oil provides readily available energy and may support growth in preterm and low birth weight infants. **Methodology:** This randomized controlled trial was conducted at the Department of Pediatrics, Sharif Medical City Hospital, Lahore, from August 7, 2024 to February 6, 2025. A total of 460 low birth weight neonates (birth weight <2.5 kg) aged 1-28 days were randomly assigned to receive either breast milk with MCT oil or breast milk alone. Occipitofrontal circumference (OFC) was measured at baseline and after 4 weeks of intervention. The primary outcome was mean increase in OFC. **Results:** Both groups had comparable baseline characteristics. The mean increase in OFC was 1.58±0.19 cm in the MCT oil group compared to 0.97±0.66 cm in the control group (p=0.001) after 4 weeks of intervention. **Conclusion:** Medium chain triglycerides oil supplementation significantly improved head circumference growth in low birth weight neonates compared to the control group. This substantial difference suggests MCT oil effectively enhances brain growth in this vulnerable population. We recommend considering MCT oil supplementation as a nutritional intervention in clinical practice for optimizing developmental outcomes in low birth weight infants.

INTRODUCTION

Low birth weight, which is defined as less than 2500 g, is a key indicator of maternal and fetal health, and it can predict mortality, stunting, and adult-onset chronic conditions.[1] Globally, approximately 15% to 20% of all births result in low birth weight, amounting to over 20 million births each year.[1-2] Low birth weight varies widely among regions, with evidence indicating that nearly half of cases occur in low and middle-income countries, particularly affecting the most vulnerable populations.[3]

In very low birth weight (<1.5 kg) babies, inadequate nutrition is a key factor for growth failure.[4] Preterm human milk contains higher levels of protein, sodium, chloride, and magnesium than term milk but remains below recommended levels. Low birth weight significantly impacts perinatal survival, infant health, and the risk of future developmental issues.[5] While studies assessing low birth weight exist, most are limited to single centers with minimal regional data.[4-5] Enteral medium chain triglyceride oil can be used to increase body fat stores and muscle mass.[6]

A review highlighted coconut oil's potential to benefit infants by protecting against infection, promoting weight gain, and improving skin condition through its emollient properties when applied topically.[7] Medium-chain triglyceride oil, containing 8-12 carbons, is absorbed better and offers more calories than long-chain triglyceride oil.[8] Infant formulas often include medium chain fatty acids in oils like coconut or palm kernel oil to aid fat absorption and promote growth in infants, particularly in formulas for preterm or low birth weight babies.[8-9]

It is discovered that weight gain averaged 21.8±5.2 g with oil and 22.5±7.9 g without oil, showing no significant difference (p>0.05). Head circumference mean values were 0.79±0.21 and 0.74±0.17, also not significantly different (p>0.05).[10] This study aimed to compare outcomes in low birth weight neonates with and without oral medium chain triglycerides oil. While literature suggests its effectiveness in improving neonatal weight gain and health outcomes, limited local studies exist. This research was planned to enhance local practices and guidelines for maintaining low birth weight neonates.

METHODOLOGY

This randomized controlled trial was conducted at the Department of Pediatrics, Sharif Medical City Hospital, Lahore, from August 7, 2024, to February 6, 2025. The study protocol was approved by the hospital's ethical committee before commencement. A sample size of 460 neonates (230 in each group) was calculated with 95% confidence level, 80% power of test, and expected mean increase in head circumference of 0.79±0.21 cm versus 0.74±0.17 cm based on previous literature.[10]

Neonates aged 1-28 days, of both genders, delivered after 32 weeks of gestation (confirmed by antenatal scan), and with birth weight <2.5 kg were included. Exclusion criteria were neonates with major congenital malformations, those not reaching full feeds by day 21 of life, and those who had necrotizing enterocolitis (NEC) Stage 3.

After obtaining informed consent from parents, eligible neonates were randomly allocated to either intervention (Group A) or control (Group B) using simple random sampling. At enrollment, baseline data including demographics, birth weight, APGAR score at birth, mode of delivery, gestational age, current weight, and head circumference were collected. Current weight was evaluated using a digital weighing scale (Beurer®), and head circumference was measured using a measuring tape.

In Group A (Intervention), mothers were advised to add 1 ml of medium-chain triglyceride oil (coconut oil) to 10 ml of expressed breast milk four times a day. Group B (Control) neonates received breast milk only. Both groups received standard oral calcium, phosphate, vitamin D3, iron, and multivitamins as per routine nursery practice.

All neonates were followed up in the outpatient department for 4 weeks after initiation of treatment. The primary outcome measure was the increase in head circumference, calculated by subtracting the baseline head circumference from the head circumference measured after 4 weeks of intervention.

Data in SPSS v25 was analyzed. Descriptive stats were calculated for quantitative variables (age, birth weight, gestational age, APGAR score, change in head circumference) by determining mean and standard deviation. For qualitative variables (gender, mode of delivery, maternal history of diabetes, hypertension, anemia), frequency and percentage were calculated. The primary analysis compared mean head circumference increase using independent samples t-test ($p \leq 0.05$). Stratification controlled for effect modifiers (age, gender, birth weight, gestational age, APGAR score, mode of delivery, maternal history of diabetes, hypertension, anemia). Post-stratification, independent samples t-test compared outcomes within each stratum ($p \leq 0.05$).

RESULTS

Table-1 compares demographics and clinical data between the medium chain triglycerides oil group (n=230) and the control group (n=230). It displays various variables. In the oil group, there were 125 males (54.3%) and 105 females (45.7%), while the control group had 124 males (53.9%) and 106 females (46.1%). Age categories were ≤14 days and >14 days, with 100 neonates (43.5%) aged ≤14 days and 130 (56.5%) aged >14 days in the oil group, compared to 102 (44.3%) and 128 (55.7%) in the control group. Mean age was 15.72±8.45 days for the oil group and 15.18±8.31 days for the control group.

In the intervention group, 48.7% of neonates weighed ≤2000g and 51.3% weighed >2000g, while in the control group, 48.3% were ≤2000g and 51.7% were >2000g. The mean birth weight was 1995.15g and 2016.59g, respectively. Gestational age distribution was 40.0% ≤34 weeks and 60.0% >34 weeks in the intervention group, compared to 42.2% and 57.8% in the control group. The mean gestational age was 34.96 weeks and 34.97 weeks, respectively. APGAR scores showed 40.4% with ≤6 and 59.6% with >6 in the intervention group, versus 43.5% and 56.5% in the control group. Mean APGAR scores were 7.02 and 6.99, respectively.

In the intervention group, c-section was chosen for 130 neonates (56.5%) and vaginal delivery for 100 (43.5%), while the control group had 128 (55.7%) delivered via c-section and 102 (44.3%) via vaginal delivery. Maternal diabetes affected 32.6% in the intervention and 33.5% in the control group. Maternal hypertension rates were 27.8% and 27.4% in intervention and control, respectively. Maternal anemia was present in 29.1% of the intervention group and 27.0% in the control group.

At presentation, both groups had similar baseline OFC measurements (31.03±0.21 cm vs. 30.99±0.21 cm, respectively), indicating comparable starting points. After 4 weeks of intervention, the medium chain triglycerides oil group demonstrated a significantly greater OFC (32.61±0.26 cm) compared to the control group (31.97±0.71 cm). The mean increase in OFC was substantially higher in the intervention group (1.58±0.19 cm) than in the control group (0.97±0.66 cm). This difference was statistically significant (p=0.001), indicating that medium chain triglycerides oil supplementation effectively enhanced head circumference growth in low birth weight neonates.

Table-3 presents the stratification of mean increase in occipitofrontal circumference (OFC) between the medium chain triglycerides oil group and the control group across various demographic and clinical variables.

Table 1

Comparison of distribution of different variables between groups

Variables		Groups	
		Medium chain triglycerides oil (n=230)	Controls (n=230)
Gender	Male	125(54.3%)	124(53.9%)
	Female	105(45.7%)	106(46.1%)
Age groups	≤14 days	100(43.5%)	102(44.3%)
	>14 days	130(56.5%)	128(55.7%)
	Mean±S.D	15.72±8.45	15.18±8.31
Birth weight	≤2000 g	112(48.7%)	111(48.3%)
	>2000 g	118(51.3%)	119(51.7%)
	Mean±S.D	1995.15±295.46	2016.59±308.60
Gestational age	≤34 weeks	92(40.0%)	97(42.2%)
	>34 weeks	138(60.0%)	133(57.8%)
	Mean±S.D	34.96±1.37	34.97±1.46
APGAR score	APGAR ≤6	93(40.4%)	100(43.5%)
	APGAR >6	137(59.6%)	130(56.5%)
	Mean±S.D	7.02±1.43	6.99±1.42

Mode of delivery	C-section	130(56.5%)	128(55.7%)
	Vaginal delivery	100(43.5%)	102(44.3%)
Maternal diabetes	Yes	75(32.6%)	77(33.5%)
	No	155(67.4%)	153(66.5%)
Maternal hypertension	Yes	64(27.8%)	63(27.4%)
	No	166(72.2%)	167(72.6%)
Maternal anemia	Yes	67(29.1%)	[illegible]
	No	163(70.9%)	168(73.0%)

Table 2

Comparison of OFC at intervals between groups

OFC at intervals	Groups	
	Medium chain triglycerides oil	Controls
OFC at presentation (cm)	31.03±0.21	30.99±0.21
OFC after 4 weeks (cm)	32.61±0.26	31.97±0.71
Mean increase in OFC (cm)	1.58±0.19	0.97±0.66
p-value	0.001	

Table 3

Stratification of mean increase in OFC between groups with respect to different variables

Variables	Groups		p-value
	Medium chain triglycerides oil	Controls	
Gender			
· Male	1.58±0.20	1.04±0.64	0.001
· Female	1.55±0.20	0.88±0.66	0.001
Age groups			
· ≤14 days	1.55±0.21	1.11±0.60	0.001
· >14 days	1.58±0.20	0.85±0.67	0.001
Birth weight			
· ≤2000 g	1.57±0.20	0.94±0.67	0.001
· >2000 g	1.56±0.20	0.99±0.64	0.001
Gestational age			
· ≤34 weeks	1.56±0.21	0.96±0.69	0.001
· >34 weeks	1.57±0.20	0.97±0.62	0.001
APGAR score			
· APGAR ≤6	1.56±0.21	1.03±0.63	0.001
· APGAR >6	1.57±0.20	0.94±0.67	0.001
Mode of delivery			
· C-section	1.59±0.20	1.00±0.68	0.001
· Vaginal delivery	1.54±0.19	0.93±0.62	0.001
Maternal diabetes			
· Yes	1.57±0.19	0.98±0.62	0.001
· No	1.56±0.21	0.96±0.67	0.001
Maternal hypertension			
· Yes	1.57±0.19	0.92±0.62	0.001
· No	1.56±0.20	0.98±0.67	0.001
Maternal anemia			
· Yes	1.56±0.19	0.91±0.62	0.001
· No	1.57±0.20	0.99±0.67	0.001

DISCUSSION

This randomized controlled trial evaluated the effect of medium chain triglycerides (MCT) oil supplementation on head circumference growth in low birth weight neonates. Our findings showed a substantial increase in mean head circumference in the MCT oil group (1.58±0.19 cm) than in the control group (0.97±0.66 cm), and difference was statistically significant (p=0.001).

The nutritional management of low birth weight infants remains challenging, with optimal growth being a critical goal of neonatal care. Head circumference is particularly important as it correlates strongly with brain growth and subsequent neurodevelopmental outcomes. MCT oil has gained attention as a potential nutritional supplement due to its unique metabolic properties, including easier digestion and more efficient absorption compared to long-chain triglycerides.[11-12]

Our study demonstrated a statistically significance and all subgroups showed meaningful benefits from MCT oil supplementation. Either gender neonates, age groups, neonates with either gestational age groups, those with either APGAR score groups, and vaginally or c-section delivered neonates, all showed significantly greater head circumference gains with MCT oil supplementation. This finding aligns with previous research suggesting that certain populations may be more responsive to nutritional interventions.[13-14]

The mechanism behind MCT oil's potential benefits likely relates to its unique metabolic properties. MCTs are more readily hydrolyzed and absorbed than long-chain triglycerides, do not require carnitine for mitochondrial transport, and provide a rapid source of energy. These properties may be particularly beneficial for preterm and low birth weight infants with limited fat stores and immature digestive systems.[15-16]

Another study demonstrated that MCT oil supplementation in premature infants was associated with improved growth parameters, including increased brachial circumference.[6] Similarly, it is. found that vegetable oil (including coconut oil, which is rich in MCTs) supplementation improved weight gain in very low birth weight infants.[15]

Our findings extend this research by specifically examining head circumference as an outcome measure. The more pronounced benefit in female neonates is particularly interesting, as it suggests potential sex-based differences in metabolism or response to nutritional interventions. Previous studies have noted sex-based differences in growth patterns and responses to nutritional interventions in preterm infants.

The significant benefit observed in neonates with gestational age ≤34 weeks suggests that more premature infants may derive greater benefit from MCT supplementation, possibly due to their more immature digestive systems and greater nutritional needs. This aligns with findings from a study that MCT-containing formulas might be particularly beneficial for more premature infants.[17]

Our study has several limitations. The relatively short follow-up period of 4 weeks may not have been sufficient to detect more pronounced differences in head circumference growth. Additionally, while head circumference is an important parameter, future studies should include long-term neurodevelopmental outcomes to better understand the clinical significance of the observed growth differences.

CONCLUSION

Medium chain triglycerides oil supplementation significantly improved head circumference growth in low birth weight neonates compared to the control group. This substantial difference suggests MCT oil effectively enhances brain growth in this vulnerable population. We recommend considering MCT oil supplementation as a nutritional intervention in clinical practice for optimizing developmental outcomes in low birth weight infants.

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