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Randomized control trials

The effects of different lipid emulsions on the lipid profile, fatty acid composition, and antioxidant capacity of preterm infants: A double-blind, randomized clinical trial

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SUMMARY

Background & aims: Olive oil (OO), medium-chain triglycerides (MCT)/long-chain triglycerides (LCT) mixture and soybean oil (SO) lipid emulsions are currently used for preterm infants in China. The aim of our study was to compare the lipid profile, fatty acid composition, and antioxidant capacity of preterm infants administered OO, MCT/LCT, or SO lipid emulsions.

Methods: In this study, 156 preterm infants (birth weight < 2000 g and gestational age < 37 weeks) received parenteral nutrition (PN) containing OO, MCT/LCT, or SO lipid emulsions for a minimum of 14 d. On days 0, 7, and 14, the lipid profile, fatty acid composition and antioxidant capacity were analyzed.

Results: On day 7, HDL levels in the MCT/LCT group were significantly lower than in the OO (1.06 ± 0.40 mmol/L) or SO groups. LDL levels were higher in the OO group than in the MCT/LCT or SO groups on day 7. A-I/B was higher in MCT/LCT than in OO or SO groups. Myristic acid (C14:0) levels on days 7 and 14 increased in MCT/LCT compared to the OO and SO groups. The OO group had higher oleic acid (C18:1n9) levels than the two other groups. Linoleic acid (C18:2n6), linolenic acid (C18:3n3), and eicosapentaenoic acid (20:5n3) were significantly lower in the OO group than in MCT/LCT or SO groups. Monounsaturated fatty acid levels decreased, and ω-6 polyunsaturated fatty acid and essential fatty acids levels increased in MCT/LCT and SO groups. No significant differences were obtained in SOD, MDA, GSH-Px, and T-AOC among the groups.

Conclusion: The three lipid emulsions were safe and well tolerated in preterm infants. Oleic acid (C18:1n9) levels increased and LA (C18:2n6), ALA (C18:3n3), and EPA (C20:5n23) levels decreased in OO compared to MCT/LCT or SO.

Clinical trial registration number: NCT01683162, https://register.clinicaltrials.gov/.

Abbreviations: ALA, α-linolenic acid; ApoaI, apolipoprotein aI; Apob, apolipoprotein b; ARA, arachidonic acid; BUN, blood urea nitrogen; Cr, creatinine; DHA, docosahexaenoic acid; EN, enteral nutrition; EPA, eicosapentaenoic acid; EFA, essential fatty acids; GSH-PX, glutathione peroxidase; GGT, gamma glutamyltransferase; Hb, hemoglobin; HDL, high density lipoprotein; LA, linoleic acid; LCT, long-chain triacylglycerols; LDL, low density lipoprotein; LP(a), lipoprotein (a); MDA, malondialdehyde; MCT, media-chain triacylglycerols; MUFA, monounsaturated fatty acid; OO, olive oil; PN, parenteral nutrition; PLT, platelets; PUFA, polyunsaturated fatty acid; RBC, red blood cell; SOD, superoxide dismutase; T-AOC, total-anti-oxidizing-capability; TC, total cholesterol; TG, triglyceride; WBC, white blood cell.

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1. Introduction

Parenteral nutrition (PN) has revolutionized the care of neonates who are unable to sustain adequate growth with enteral nutrition (EN). Long-term PN use was first described in a female neonate [1]. Currently, more than 30,000 patients, young and old, depend on PN for survival, and more than 350,000 patients in the USA receive PN on a yearly basis [2]. Lipid emulsions, an important component of PN, reduce the side effects associated with high glucose intakes [3,4], provide essential fatty acids (EFAs) [5,6], and improve nitrogen balance [7].

Conventional lipid emulsions are prepared with soybean oil (SO), which is rich in polyunsaturated fatty acids (PUFAs), such as linoleic acid (LA) and α-linolenic acid (ALA). The adequacy of SO-based emulsions for the nutritional requirements of full-term and preterm infants has been questioned, mainly because of the high concentrations of LA and ALA. Long term use of SO-based emulsions may deplete the antioxidant defense system of the individual [8], increasing the risk of peroxidation, especially in preterm infants. To reduce antioxidant requirements and decrease the potential negative effects with ω-6 PUFAs, MCT/LCT-based lipid emulsions have been developed. MCT/LCT-based emulsions have lower ω-6 PUFAs content but similar ω-6:ω-3 PUFA ratio (7:1) as SO-based emulsions. Olive oil (OO) emulsions contain 20% soybean oil and 80% olive oil, with 20% of PUFAs and a 60% of monounsaturated fatty acids (MUFAs). Even though several studies have assessed the effects of OO and SO in neonate nutrition [9–12], the effects of OO, MCT/LCT, and SO emulsions on both lipid metabolism and antioxidant capacity have not been studied in preterm infants. The objective of this study was to determine the effects of these three lipid emulsions on the lipid profiles, fatty acid (FA) composition, and antioxidant capacity of preterm infants.

Table 1
Composition of lipid emulsion.

Ingredient	OO	MCT/LCT	SO
Contents (g/100 mL)			
Soybean oil	4	10	20
MCT	–	10	–
Olive oil	16	–	0
Egg-yolk phospholipids	1.2	1.2	1.2
Glycerol	2.25	2.5	2.25
Sodium oleate	0.03	–	–
α-Tocopherol (mg/L)	30	11	27
Fatty acid (mol%)			
Palmitic acid (C16:0)	13.5	6.5	11.0
Stearic acid (C18:0)	2.9	2.0	4.3
Oleic acid (C18:1n9)	59.5	11.0	21.0
LA (C18:2n6)	18.5	26.0	52.0
ALA (C18:3n3)	2	3.5	7.0
AA (C20:4n6)	<0.5	<0.5	<0.5
PUFA (%)	20.5	29.5	59.0

LA: linolenic acid; ALA: α-linolenic acid; AA: arachidomic acid; LCT: long-chain triglyceride; MCT: medium-chain triglyceride; PUFA: polyunsaturated fatty acids; OO: olive oil; SO: soybean oil.

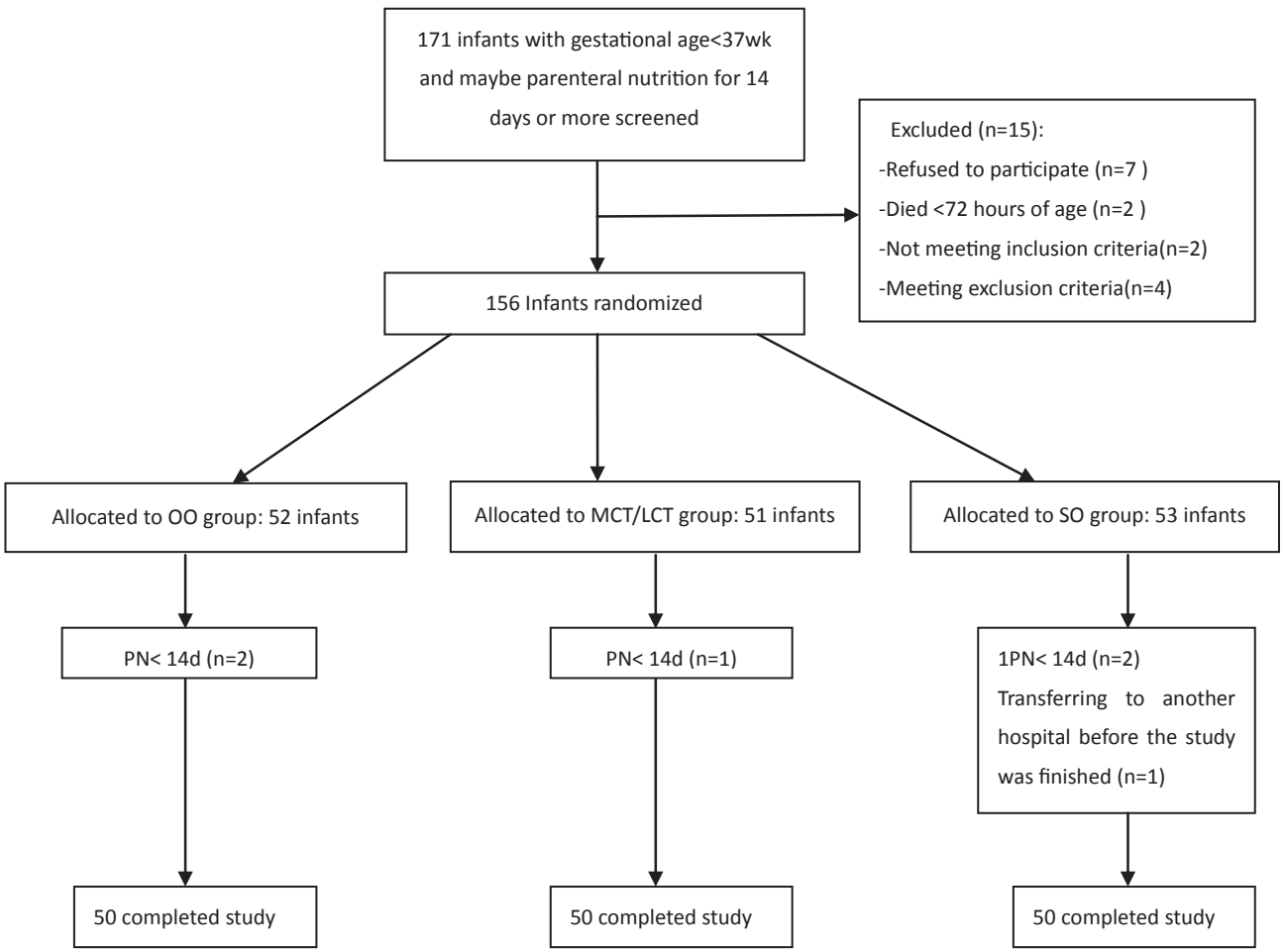

Fig. 1. Preterm infants (n = 156) were randomly assigned to the OO, MCT/LCT, or SO groups. Two infants in the OO group, one infant in the MCT/LCT group, and two infants in the SO group were on EN before day 14; one infant was transferred to another hospital before the study was completed. One hundred fifty infants completed this study.

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