The development of a pig model to test the role of exogenous lipases in fat absorption when fed human infant milk formula

SG Pierzynowski[1], K Goncharova[2], T Kovalenko[2], I Osadchenko[2], G Ushakova[3], G Skibo[2], A-Ch Olsson[4], J Svendsen[4]

[1]*Dept of Biol., U of Lund, Sweden & Inst of Rural Health, Lublin, Poland,* [2]*Dept of Cytology, Key State Lab, Bogomoletz Inst of Physiol, Kyiv, Ukraine,* [3]*Dept of Biochem and Biophys, DNU, Dnepropetrovsk, Ukraine,* [4]*Swedish Univ of Agricul Sciences, Dept of Biosys and Techn (BT), Alnarp, hyocon@gmail.com*

Introduction

The exocrine pancreas is fully functional in the newborn pig. However, the neonatal human must obtain pancreatic lipases from mother's milk. Thus, the human infants fed milk formula cannot properly digest dietary fat, which is necessary, e.g., for the proper growth of the neonatal brain. It has been shown that many aspects of postnatal development are similar between the human and the piglet, with the exception of the exocrine pancreas. A model of exocrine pancreatic insufficiency in the young pig (EPI pigs) has been developed and is well established; these animals do not grow and have very poor fat and protein absorption (1,2,3,4). Thus the possibility of using this animal model for studying lipid metabolism and absorption in human pre- and full-term infants was investigated in the following study.

The aim was to determine the effect of feeding a standard neonatal formula, treated and not treated with microbial lipases to EPI pigs and relate the observations to those observed in infants fed non-treated similar formulae.

Materials and Methods

Animal material, maintenance systems and pancreatic duct ligation surgery, recovery and adaptation procedures have been reported (2). A partially hydrolyzed infant starter formula milk NAN Pro 1 Gold (Nestle) was used. Based on avg. body weight, the EPI pigs were fed approx. 400-500 g formula powder daily in 4 feeds. Microbial lipase was used for the digestion of the long chain polyunsaturated fatty acids (LCPUFA) in the formula. 13 male EPI pigs (aged 8±2 wks and weighing ca 13±2 kg at start), received formula during the 2 wks of pre-treatment period. For the 1 wk treatment period, they were divided into 2 groups. The control group (n=4) was fed formula only. The experimental group was fed milk prehydrolyzed with microbial lipase (n=9). Blood samples were collected daily before feeding.

The animals were sacrificed at the end of the study and post-mortem examined. Histological examination of the gastrointestinal tract was carried out using standard methods. Standard methods were used to analyze the levels of total fat, free fatty acids, triglycerides (TG) and non-esterified fatty acids (NEFA). The Lipemic Index (LI) and coefficient of fat absorption (CFA) were calculated. Statistical analyses using Statistica 7 (StatSoft, USA) were carried out.

Results

The lipase group ate less than the control and no EPI group gained weight. The lipase treated group had lower stool weights and significantly ($p<0.01$) lower total fat content than the control group (53.5% vs 30%). The coefficient of fat absorption (CFA) in the EPI pigs increased up to 87% ($p<0.05$) with lipase treatment, whereas that of the control pigs remained ca. 66-67%. The lipase treated group showed a significant increase in the LI, and significant changes in post prandial serum NEFA. Neither the mucosal thickness of the small intestine nor the number of goblet cells in the mucosa of the EPI pigs were increased by predigestion of the formula with lipase, in contrast to observations made on intact pigs fed formula.

Conclusions and Discussion

Formula intake is optimal for term and preterm neonates when breast feeding is impossible, and if pasteurization is required for donor breast milk. Infants fed formula supplemented with taurine, a bile acid, showed a higher CFA than those fed untreated formula (5). A similar increase in the CFA of the EPI pigs was found when they were fed lipase treated formula. The results of the present study indicated that the response of the EPI pigs was similar to those of infants with neonatal physiological pancreatic insufficiency.

Thus there are indications that the EPI pig can be used as an animal model of the infant of 3-6 months of age to test lipid metabolism and absorption of pre-hydrolyzed TG-fats.

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References

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