Early Human Development (2007) **83**, 693–696

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Neonatal taurine administration modifies metabolic programming in male mice

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Accepted 24 March 2007

KEYWORDS
Taurine;
Neonatal administration;
Glycaemia;
Lipids;
Programming;
Mice

Abstract

The semi-essential amino-acid taurine is involved in glucose homeostasis either in adults or in parental life. Taurine is currently used in neonatal life because it is added to milk formula for babies, and to parental solution for prematures. Here, it has been examined whether taurine administration in lactation modifies adult glucose metabolism. Neonatally taurine-treated mice (50 mg/kg body weight/day, for the first 21 days of life) as adults have lower basal glucose and iAUC after glucose loading curves in comparison with vehicle-treated mice, whereas iAUC following insulin loading curves, plasma lipids and malondialdehyde (MDA), an index of lipid peroxidation were not significantly changed. Thus, in rodents, neonatally administered taurine produces enduring effects in a way that could be advantageous for the control of glucose homoeostasis.

1. Introduction

Nowadays, the impact of the early life environment on lasting determination of fundamental processes of life is more and more accepted [1–7]. In this context, the possibility of perinatal prophylaxis assumes a great importance [8,9].

Taurine is a sulphur amino acid that is normally added to milk formula and in solution for parenteral nutrition for prematures to prevent retinal degeneration and cholestasis [10,11]. More recently, it has been shown that gestational taurine is able to prevent pancreatic alterations induced by gestational malnutrition especially low-protein diet [12–19]. In addition, taurine administration during gestation delays the mean onset time of diabetes in NOD mice [20]; whereas taurine supplementation on dams fed with normal diet produces a weak glucose intolerance, and increases islet sensitivity to cytokines in offspring [16]. Moreover, taurine plays a role in glucose metabolism in adults [21–23].

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doi:10.1016/j.earlhumdev.2007.03.011

Table 1 Plasma lipid profiles and MDA measured in adult (100 days of age) mice

Groups	Cholesterol (mg/dL)	LDL (mg/dL)	HDL (mg/dL)	VLDL (mg/dL)	TG (mg/dL)	MDA (nmol/mL plasma)
Vehicle	91.2±9.3	5.9±2.4	68.2±7.4	44.3±3.4	121.1±18.7	1.3±0.1
Neonatal taurine	96±6.5	6.5±1.7	66.7±4.8	42.9±4.1	112.5±10.6	1.3±0.2

Data are the means±S.E.M. of 11 animals.

To the best of our knowledge, the long lasting effects of postnatal taurine administration on glucose metabolism and on lipid and lipid peroxidation are still unknown, although neonatal taurine administration exerts enduring effects on hippocampal synaptogenesis [24], and an antioxidant mixture containing taurine administered in perinatal life can reduce systolic blood pressure [25]. Therefore it has been investigated whether taurine administration during lactation has enduring effects on glucose homeostasis, plasma lipid profile and peroxidation.

2. Materials and methods

Experiments were approved by the Ethic Committee of the Istituto Superiore di Sanità (Roma, Italy). Animals were housed under controlled conditions of temperature (23± 2 °C), humidity (55±5%) and lighting (12-h periods of light and darkness) with free access to food (Mucedola S.r.l., Settimo Milanese, Italy) and water.

Pregnant CD-1 mice (Charles River Italia, 22050 Calco, Italy) were received at gestational day 14 and housed one per cage. Details of experimental procedures used have been given previously [7,24] and here we present those details that are central to this study. Briefly, dams were checked at 08:00 and 16:00 and in about 12 h, litters (13±1 subjects) of homogeneous weight male mice were constituted and randomly culled to six male pups so that all pups were randomly cross fostered. Each litter was then randomly assigned to vehicle group or taurine group. For 21 days, pups of vehicle group were weighed and subcutaneously injected with saline solution (1 mL/kg body weight), while the other group received subcutaneously 50 mg/kg body weight of taurine (Sigma, St Louis, USA). The previous procedure requires 10 min. Litters were weaned at postnatal day 21 and were housed three per cage until they reached 90–110 days of age.

2.1. Insulin and glucose load curves

Overnight fasting adult mice underwent an intraperitoneal tolerance glucose test; being D-glucose (2 g/kg body weight) administered between 09:00–11:00 am. For the insulin

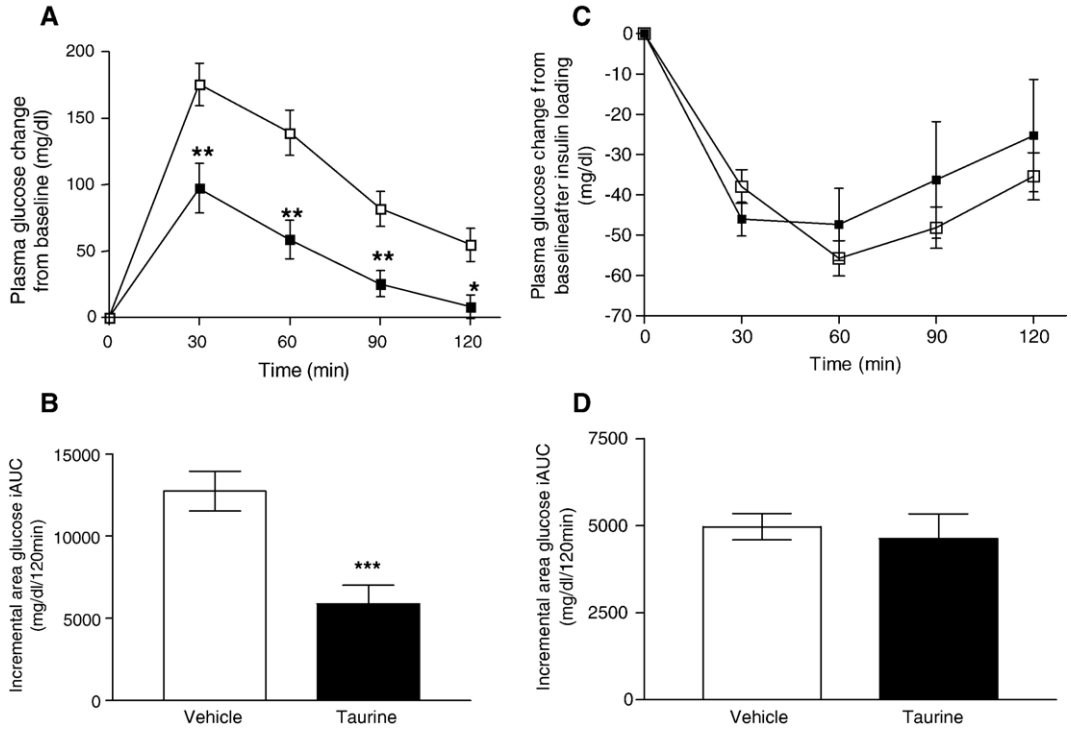

Figure 1 (A), Glucose loading curves performed in adult mice neonatally treated with vehicle (□, $n=26$) and taurine (■, $n=16$). (B), iAUC calculated from glucose loading curves. (C), Plasma glucose changes from baseline after insulin loading measured in adult mice neonatally treated with vehicle (□, $n=24$) and taurine (■, $n=14$). (D), iAUC calculated from glucose curves measured after insulin loading. Values are means±S.E.M. $^{*}0.05<p<0.01$; $^{**}0.01<p<0.001$; $^{***}0.001<p<0.0001$.