Perinatal changes in plasma carnitine levels in 4 species of mammal

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Summary. Plasma levels of carnitine, acetylcarnitine, and β-hydroxybutyrate rise perinatally in rats, guinea-pigs and sheep but not in rabbits. In the fetus, carnitine levels are high in rabbits and guinea-pigs but not in rats and sheep.

We have shown previously that plasma levels of free and esterified carnitine increase perinatally in the rat[1]. Since carnitine is thought to be essential for optimum mitochondrial fatty acid oxidation[2] we concluded that this rise, which correlates well with the sudden perinatal increase in plasma ketone content[3], reflects early postnatal lipid oxidation.

It was of interest to know whether these perinatal changes occur also in other species whose fetuses, in contrast to the rat, have been reported to be able to oxidize fatty acids at essentially adult rats[4]. Rabbits and guinea-pigs represent such species. In them, placental transport of carnitine is rapid (unpublished data) while in the rat[5] and in the sheep[6], very little maternally derived carnitine is found in the fetal circulation.

Pregnant rabbits (2–3 days before term) were sacrificed by i.v. injection of air into an ear vein, pregnant guinea-pigs by decapitation with a guillotine. Blood was collected into heparinized tubes. The fetuses were immediately decapitated and then blood was also collected. Postnatal animals were sacrificed in the same manner. Fetal sheep blood was collected from chronically implanted catheters as described previously[7].

Blood from newborn animals was taken from the jugular vein under light anesthesia.

Free and total carnitine and β-hydroxybutyrate levels were determined as described previously[1]. It is apparent from the table that total carnitine levels are considerably higher (and equal to maternal levels) in rabbits and guinea-pigs than in rats and sheep. In the latter 2 species, there is a pronounced postnatal rise completely absent in rabbits and transient in guinea-pigs.

Acylcarnitine levels are very low in rats and sheep but relatively high in the other 2 species. They rise postnatally except in rabbits where a decrease was found. The ratio of acyl- to free carnitine increased postnatally in all species except the rabbit. Similarly, there was a pronounced rise in the level of β-hydroxybutyrate in the three species but not in rabbit.

Our data show that the 4 species examined can be separated into 2 groups. One (rats and sheep) has low plasma levels of carnitine and acylcarnitine in the fetus that rise within 1 day after birth. The other (rabbits and guinea-pigs) has high levels of these substances already prenatally. However, rabbits seem to differ from guinea-pigs insofar as there is a fall in carnitine levels perinatally. This may be related to the fact that rabbits are suckled only once a day and that hence blood levels fluctuate during the day. However, it should be noted that 1-day-old rabbits also have the lowest β-hydroxybutyrate levels of the 4 species, suggesting that the perinatal fall in acylcarnitine levels is not due to a prolonged period of starvation. Rabbits are also the only species in whom there was no significant perinatal rise in the level of β-hydroxybutyrate.

Our data suggest that even though there is some correlation between blood levels of acetylcarnitine and β-hydroxybutyrate, and between the ratio of acyl- to free carnitine and this ketone, as shown previously[1,7], there might be another role for carnitine in the fetal rabbit and guinea-pig which is not related to lipid oxidation. This is also indicated by the fact that the activity of hepatic carnitine acetyltransferase is high in fetal rabbits and guinea-pigs but not in fetal rats[8].

Plasma carnitine and β-hydroxybutyrate levels in 4 species (μM)

Species	No. of animals		Carnitine (μmoles/l; means ± SE) Free	Acyl	Total	Ratio acyl/free	nmoles/l β-hydroxybutyrate
Rat*	Fetus	20	15.0±0.76	5.4±0.84	20.3±1.3	0.357	0.192±0.051
	1-day-old	8	27.3±0.8	16.4±1.1	43.6±1.4	0.603	0.92 ±0.130
	Mother	8	24.2±1.3	13.3±2	37.5±2.3	0.561	0.168±0.103
Guinea-pig	Fetus	7*	34.3±1.9	18 ±3.6	53.0±5.1	0.537	0.256±0.04
	1-day-old	6	28.4±4.9	45.9±3.2	74.3±3.2	1.775	1.236±0.217
	6-day-old	4	25.2±4.6	22.1±2.4	48.3±5.2	0.470	
	Mother	4	21.1±6.6	39 ±9.6	58.7±14.7	1.963	0.748±0.186
Rabbit	Fetus	12	19.6±1.3	31.3±1.6	50.8±5.1	0.537	0.256±0.02
	1-day-old	6	13.5±0.7	17.6±1.2	32.2±2.1	0.54	0.454±0.17
	Mother	3	20.3±3.0	28.1±1	48.4±6.0	1.829	1.767±0.15
Sheep	Fetus	4	9.2±0.5	4.3±0.2	13.4±0.6	0.46	0.259±0.03
	1-day-old	8	17.9±0.7	8.3±1.1	26.15±1.12	1.829	1.08 ±0.2
	Mother	4	20.3±1.0	28 ±0.12	48.4±2.0	1.38	1.767±0.2

* From Seccombe et al.[1]. All fetuses in all species were preterm, except in the sheep (20 days preterm).

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