Transfer of PCDDs, PCDFs and non-ortho Co-PCBs via Placenta from Japanese Mother Blood to Umbilical Blood as Fetus Blood

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Introduction

Polychlorinated dibenzo-p-dioxins (PCDD), polychlorinated dibenzofurans (PCDF) and non-ortho coplanar PCBs (Co-PCBs) are three classes of structurally and toxicologically similar persistent environmental contaminants. These compounds are formed as by-products in various chemicals[1)] and combustion process[2-4)] and are now global environmental contaminants. Recently, much importance has been attached to the problem of environmental pollution by PCDDs, PCDFs and Co-PCBs released from municipal solid waste (MSW) incinerators in Japan[5)], because the numbers of MSW incinerators and industrial waste incinerators were 1841[6)] and over 20000 in our country, respectively. Therefore, many Japanese have concerned about their adverse effect on the health; they usually might intake food, air and water etc., which highly contaminated by such dioxin analogues. Especially, there are incessantly taken by a feeling of unrest, with respect to the reproduction toxicity and endocrine disruption for fetus or infants who have weak resistance against dioxins or other toxic compounds. Practically, in order to evaluate the exposure and attendant risk to fetus and newborn babies from dioxin analogues, it demands the reliable data on the concentrations of these compounds in human mother blood, placenta and umbilical blood as fetus contamination indicator. However, little is known about the placental transport of dioxins from mother to fetus[7-10)]. Schecter et al.[7)] showed evidence of transplacental transfer, but most data are derived from animal studies both in primates and in rats. Kappe et al[8)] also investigated that the levels of dioxins in liver or fat of four human fetus and two human babies who died early. But, it has not reported that transport rate of dioxin analogues via placenta from mother blood to fetus blood.

In this article, we investigated the contamination levels of PCDDs, PCDFs and non-ortho Co-PCBs in placenta, mother blood, umbilical blood and mother milk obtained from ten women at normal delivery, and further the transport rate of these compounds via placenta from mother blood

to umbilical blood.

Materials and Methods

1) Samples

The samples (about 600g of placenta, 50 ml of mother blood, 30ml of umbilical blood and 50 ml of mother milk) were collected from 20 pregnants who term infants were normally delivered, during a period of February to November in 1998. Each sample of placenta and mother milk, and both bloods samples as 1 group collected from 10 pregnants, were used for the analysis of dioxin analogues.

2) Analytical procedure

100 g of placenta and 50ml of mother milk, and 50ml of serum as mother and umbilical blood from same women, were used for dioxin analysis; each sample was extracted according to the modificated method of Patterson et al.[13], after addition of internal standards (five $^{13}C_{12}$-PCDDs and five $^{13}C_{12}$-PCDF and four $^{13}C_{12}$-Co-PCBs, each 100 pg). Then, these extracts were cleaned up on a multi-layer column containing Na_2SO_4 (2.0 g), 10%(w/w) $AgNO_3$-silica (8.0 g), silica (0.8 g), 22%(w/w) H_2SO_4-silica (4.0 g), 44%(w/w) H_2SO_4-silica (4.0 g), silica (0.8 g), and 2%(w/w) KOH-silica (3.0 g), silica (0.8 g) with an eluent of n-hexane (210 ml). The elute was concentrated and purified by alumina column according to our previous reports[11-12]. The purified extract was dissolved in 10 or 20 μl of n-decane and analyzed for PCDDs, PCDFs and Co-PCBs in EI-SIM mode at a resolution of 10000 using a Hewlett Packard 6890J gas chromatograph-JEOL JMS700 mass spectrometer. The above experiments were performed twice, and evaluated. Finally, to compare the toxic level by PCDDs, PCDFs and Co-PCBs in analyzed samples, the values of 2,3,7,8-TCDD toxic equivalent quantity (TEQ) were calculated for PCDDs, PCDFs and non-ortho Co-PCBs using 2,3,7,8-TCDD Toxicity Equivalence Factors (WHO-TEFs)[14].

Results and discussion

As shown in Figure 1, It was compared that the average concentrations (TEQ) of dioxin analogues in placenta and mother milk from each five primiparae and five multiparae. As results, it was observed that both concentration in placenta and mother milk from primipara is higher than those from multipara: with respect to the placenta, total TEQ concentration in the placenta from primipara and multipara was 81.4 and 53.2 pg/g lipid, respectively. Similarly, the concentration in mother milk from primipara and multipara was 31.4 and 25.2 pg/g lipid, respectively. The main reason for the decrease of level of dioxin analogues in the samples of multiparae was considered to lactate for previous infants. Therefore, their lactation seems to be reduced the body burden by dioxin congeners. Table 1 shows the TEQ concentrations of dioxin analogues in each mother and umbilical blood sample from 10 pregnants at delivery and the transfer rate (%) via placenta. As their concentration per g serum base, it was observed that the concentration in mother blood sample and umbilical blood sample was 0.189 pg and 0.048 pg, respectively, and the transfer rate

was 25%. On the other hand, as the concentration per g lipid base, 22.7 pg TEQ in mother blood samples and 20.5 pg TEQ in

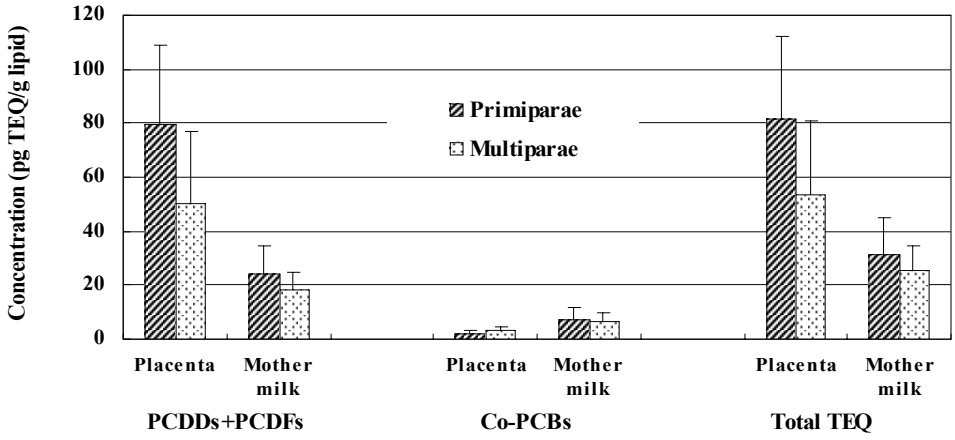

Figure1. Comparison of dioxin analogue concentration (TEQ) in placenta and mother milk from five primiparae and five multiparae

Table 1. Concentrations (TEQ) of dioxin analogues in mother and umbilical blood sample from 10 pregnants at delivery and the transfer rate (%) via placenta

	(A) Mother blood sample		(B) Umbilical blood sample	
Base unit	pg /g serum	pg/ g lipid*	pg /g serum	pg/ g lipid*
PCDDs	0.077	9.2	0.020	8.5
PCDFs	0.058	6.9	0.016	6.7
Co-PCBs	0.054	6.6	0.012	5.3
Total TEQ	0.189	22.7	0.048	20.5
Transfer rate (%) = Total TEQ (B/A) : serum base; 25%, lipid base; 90%				

*** Lipid content in mother blood and umbilical blood as whole blood was 0.42% and 0.12%, respectively**
Both blood samples as 1 group collected from 10 pregnants at delivery were used for the analysis of dioxin analogues.

umbilical blood sample were recognized, and the transfer rate was 90%. The reason why the rate evaluated by lipid base was very high, due to low content (0.12%) of lipid in umbilical blood sample, comparison with that (0.42%) in mother blood sample. Therefore, it was considered that placenta has no function of protection against dioxin analogue contamination. Koppe et al.[8] estimated that the fatty acids or lipoproteins like LDL are play an important role in placental transport by dioxin congener. Patterson et al.[13] reported that the lower chlorinated PCDDs/PCDFs like 2,3,7,8-TCDD is partitioned among the various blood compartments, such as lipoproteins and proteins, according to their lipid content, but the higher chlorinated PCDDs/PCDFs do not appear to partition according to lipid content from in vitro and in vivo experiments. When we investigated the transfer rate from mother blood to umbilical blood, it was recognized that almost dioxin congeners showed high rate over 80%, but HpCDD and OCDD was low rate in the range of 40 to 60%. This observation result seems to the difference of localization of each isomer in various components as dioxin carrier in blood, and of placental transport mechanism by their carriers. However, in any event, it was elucidated that human fetus is contaminating by dioxin analogues soon after fertilization, and further newborn baby is also contaminating by breast-feeding from birth. Consequently, from our results, we considered that the human risk assessment is necessary to completely distinguish between infants who have weak protection and adults.

Hereafter, we plan to clarify the concentrations and their patterns of various sex hormones in human blood, urine and tissues by GC-MS, and to elucidate the endocrine disruption by dioxin congeners.

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