CONCENTRATIONS OF PCDDs/PCDFs, HCB and PCBs IN HUMAN PLACENTAL AND ADIPOSE TISSUE

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ABSTRACT

Placental and adipose tissue of eight women were analysed for PCDDs/PCDFs, HCB and PCBs. Although the concentration of all of these pollutants was low in the placenta on a wet weight basis, a reasonable correlation for most of the substances was found between the concentrations in placental fat and in adipose tissue of the same woman. Thus, although fetal tissue, the placenta seems to largely mirror the body burden of the adult organism, based on the fat content.

ABBREVIATIONS

TCDD = 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin;
PCDDs = Polychlorinated dibenzo-*p*-dioxins;
PCDFs = Polychlorinated dibenzofurans;
HCB = Hexachlorbenzene;
PCBs = Polychlorinated biphenyls;
I-TE = International toxic (TCDD) equivalency factors

INTRODUCTION

A comparatively large amount of data exist on the concentrations of lipophilic pollutants in adipose tissue. Since concentrations in milk fat seem to correspond to the concentrations in adipose tissue of the same woman, probably a considerable exposure of the baby results during lactation. However, it should be considered that little information is available on the absorption of such pollutants from the gastrointestinal tract of a breast-fed baby. Animal experiments with TCDD or PCDD/PCDF-mixtures indicate that the exposure of the fetus is apparently low, compared to the considerable exposure which takes place during the lactation period. However, since very little direct information exists on the concentrations in adipose tissue and other organs of the human fetus, or in newborn or infants at the end of a breast-feeding period, it is presently impossible to assess the transfer rates during these periods.

We were interested in answering the question whether the concentrations of lipophilic pollutants in placental tissue mirror the body burden of the mother or if they give some indication on fetal concentrations. For this purpose small samples of adipose tissue and the placenta were secured during caesarean sections for analysis and concentrations of PCBs, HCB and PCDDs/PCDFs were measured. Here we present the first comparative data on the concentrations of PCDDs/PCDFs, hexachlorbenzene and polychlorinated biphenyls in placental and adipose tissue from eight women.

MATERIALS AND METHODS

Adipose (about 2 g) and placental tissue of the same patient were obtained during a ceasarean section. The placenta was freed of embryonic membranes and about 100 g was minced. All samples were frozen at -30° C. For analysis samples were ground in a mortar with four volumes of sodium sulfate. Fat extraction was carried out on chromatography column with cyclohexane/methylenechloride (1+1; v/v). For quantification and to determine recovery the following ^{13}C-labelled compounds were added: 2,3,7,8-T4CDF, 2,3,7,8-T4CDD,

1,2,3,7,8-P5CDF, 1,2,3,7,8-P5CDD, 1,2,3,4,7,8-H6CDF, 1,2,3,7,8,9-H6CDD, 1,2,3,4,6,7,8-H7CDF, 1,2,3,4,6,7,8-H7CDD, OCDF and OCDD. For chromatographic clean-up the following steps were applied: (1) column of silica gel/H_2SO_4 and silica gel/NaOH, (2) charcoal (Carbopack C/Celite 545), (3) $AgNO_3$/silica gel - Al_2O_3. The concentrations of HCB and PCB were measured in the first fraction of the active carbon eluate by means of gaschromatography and an electron capture detector (ECD). For quantification Mirex was added as internal standard. For PCDD/PCDF detection a Finnigan MAT 8230 mass spectrometer was used at a high resolution technique.

RESULTS

On a wet weight basis the concentrations of all pollutants measured in the placenta were about two orders of magnitude lower than on the fat basis. The fat content of the placental tissue ranged from 0.6 to 1.0% of the wet weight. In this paper the results are discussed with respect to the concentrations in the fat of placental and adipose tissue, and not to the wet weight of the organs. A comparison of the concentrations of the pollutants in placental fat of the subjects studied shows that patient # 8 had the highest concentrations of the cohort for most compounds (except OCDD), whereas patient # 3 showed, in general, rather low concentrations. However, no simple correlation, which would fit to all substances in all patients between the concentrations of the pollutants in adipose and placental tissue, was found. In fact, the situation seemed to differ for every substance analysed.

The values for **2,3,7,8-T4CDD** (Fig. 1a) in adipose tissue were in the expected range (mean ± SD: 3.0 ± 1.1 ng/kg). Surprisingly, all concentrations measured in the placental fat were *higher* with a mean value ± SD of 7.3 ± 2.3 ng/kg (ppt). A similar situation also existed for the concentrations of **2,3,4,7,8-P5CDF** (Fig. 1b). All patients but one (# 8) had higher concentrations of this congener in the placental fat than in the adipose tissue. The mean value ± SD for the concentration ratios of this congener in the fat of adipose/placental tissues was 0.61 ± 0.38.

Just the opposite situation was observed for the octachlorinated compound (Fig. 1c). **OCDD** concentrations between 224 and 910 ng/kg were measured in adipose tissue, confirming the previously published data of Beck (1990), but all concentrations of this highly chlorinated congener in the placental fat were *lower* than in the subcutaneous fat.

Since the tetra- and the penta-chlorinated congeners have a strong impact on the international toxic equivalency factors (I-TE's), the ratio of the toxic equivalencies is also < 1, and a mean value of 0.67 ± 0.30 has been calculated. Individual data are presented in Figure 1d.

Summarizing, it may be stated that the concentration ratio (fat): adipose/placental tissue increased in the group of PCDDs/PCDFs with increasing degrees of chlorination: e.g. from 0.4 ± 0.2 (2378-T4CDD) to 0.9 ± 0.5 (123478-H6CDD) and 1.6 ± 0.7 (OCDD).

Other pollutants measured showed similar ratios as found with OCDD: the corresponding ratios for **HCB** were 1.19 ± 0.33, and 2.75 ± 0.46 for **PCB 153**. Individual concentrations are given in Figures 1e and 1f. A remarkable variability of the concentrations in adipose tissue is obvious. Of the three PCB's measurable, in all patients PCB 153 showed higher concentrations (range: 70 to 520 µg/kg) than the others. All concentrations in placental fat were considerably lower. HCB concentrations of *both* tissues were only measured in five out of eight women. In four of the patients a good correlation is obvious. In one case (patient # 4) the relative concentration in adipose tissue was very high.

DISCUSSION

Although a considerable amount of data exist on the concentrations of PCDDs/PCDFs and other lipophilic pollutants in human adipose tissue (Beck, 1990; Thoma, 1989) and milk fat (Ende, 1987; Fürst et al., 1989), too few data exist on concentrations in fetuses and babies. Therefore, it is not possible to come to a final conclusion with respect to a possible risk to

babies and infants by breast-feeding. Up till now all calculations on a probable exposure of newborn during lactation are based on several assumptions: (1) It still is unknown how much prenatal exposure contributes to the body burden of a child, and (2) to what extent the pollutants in breast-milk are absorbed from the gastrointestinal tract of a baby. Recently reported first, and still very limited, data suggest that the concentrations of PCDDs/PCDFs in tissues from SIDS (sudden-infant-death) babies are surprisingly low (Beck et al., 1990), but none of these infants had been breast-fed for a prolonged period. Therefore, presently an assessment of the extent of a possible uptake of potentially toxic pollutants from mother's milk must mainly be based on asssumption.

Concentrations of PCDDs/PCDFs in embryonic or fetal tissue are generally assumed to be low, compared to the burden of the maternal organism. This has been deduced from studies in animals. Placental transfer of 2,3,7,8-T4CDD was found to be rather low in rodents (Krowke et al., 1989; Korte et al., 1990), but the uptake of this congener during the lactation period was reported to be significant. Corresponding results have also been obtained with non-human primates (Bowman et al., 1989; Hagenmaier et al., 1990). However, limited data available for other congeners do not indicate such an accumulation in the tissue of the offspring for all the congeners (Hagenmaier et al., 1990).

Human data on this topic are still non-existent. Our data indicate that in the placenta (which mainly represents fetal tissue), the tetra- and penta-chlorinated congeners such as 2,3,7,8-T4CDD or 2,3,4,7,8-P5CDF achieve relatively high concentrations in the fat and that the opposite is true for the higher chlorinated congeners. This might point to binding sites or sites of deposition for 2,3,7,8-TCDD outside of the fat, especially in some of the patients. For six of the eight patients the I-TE values were almost identical on a fat basis in adipose and placental tissue, for the remaining two patients the values in placental fat were 2 to 3 times higher. Summarizing, compared with adult adipose tissue the concentrations for PCDDs/PCDFs in placental tissue (on a fat basis) are not especially low. Thus, placental fat seems to be in a kind of equilibrium with the adipose tissue of the adult organism.

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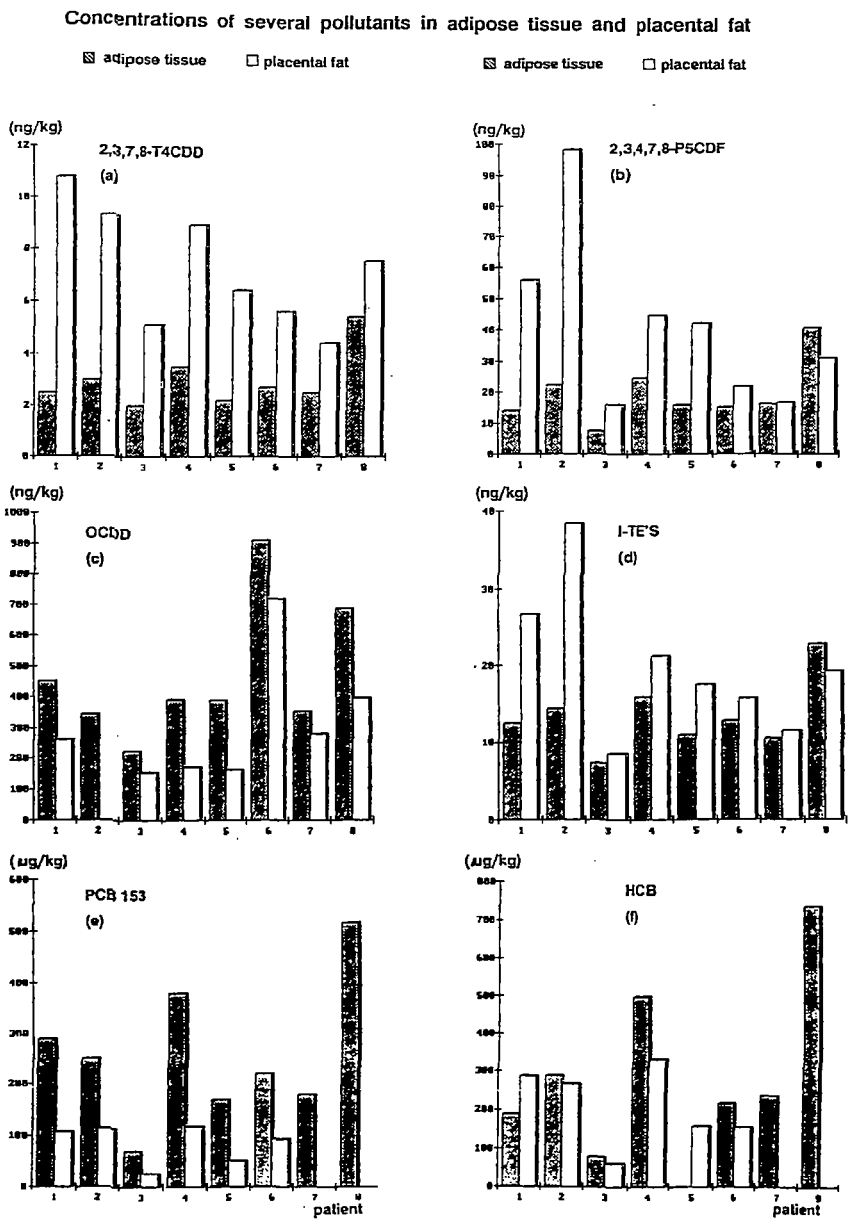
Figure 1 a-f:


Concentrations of several pollutants in adipose tissue and placental fat
adipose tissue
placental fat
(ng/kg)
2,3,7,8-T4CDD
(a)
(ng/kg)
2,3,4,7,8-P5CDF
(b)
(ng/kg)
OCDD
(c)
(ng/kg)
I-TE'S
(d)
(µg/kg)
PCB 153
(e)
patient
(µg/kg)
HCB
(f)
patient