Concentration of PCBs and chlorinated pesticides in bone lipid from Irish and British men.

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Introduction

Concentrations of toxic organochlorines in human tissues have been widely reported. However, in recent years there has been a preponderance of research on breastmilk because of the understandable concerns about exposure of the infant. The other tissue most frequently sampled is blood, which is easy to collect. Moreover, the majority of males who have been the object of research have been occupationally exposed. This study was undertaken to determine concentrations of organochlorines in bone lipid from men from the general population.

Materials and Methods

Femoral heads were collected from patients admitted for elective hip replacement surgery for oesteoarthritis. All subjects were male; 9 were from Ireland and 8 from the United Kingdom. Cores of bone were trephined from the trabecular centre of the tissue samples and extracted with chloroform/methanol (3:1 v/v). The lipid extracts were decanted into a glass tube and reduced to dryness under a stream of oxygen-free nitrogen at 50°C. The residues were resuspended in n-hexane, the solvent mixture transferred into a further glass tube and dried as described.

Lipid fractions were dissolved in hexane and treated with sulphuric acid, followed by alumina chromatography clean-up. Analysis was carried out by capillary GC-ECD using a 50m HT8 column (SGE, Milton Keynes, UK). The linearity of the detector response was confirmed by multilevel calibration for each analyte prior to analysis. Limits of detection were determined from the mean +3 standard deviations of 7 sample blanks. All samples were spiked with dichlobenil (0.25ug/ml) as an internal standard. A single working standard was analysed with each batch to calculate response factors and spiked duplicates analysed to calculate recoveries. Results are presented as arithmetic means, without correction for recovery.

Results and Discussion

Results of the analyses are given in tables 1 and 2 below. Correlations between age and organochlorine concentrations in humans has been reported previously (1,2). However, in the current study, there was considerable intra-individual variation resulting in large standard deviation values. Despite the ages of the subject varying by more than 20 years, no statistically robust age-related trends were observable.

Bone tissue has been analysed previously by Scheele and coworkers (3). This German study group included patients with leukaemia and controls, of both sexes, with a mean age of 63. No differences were detected between organochlorine concentrations in bone marrow in individuals with and without leukemia. Due to the paucity of data on bone tissues, adipose tissue data were also used for comparison below, recognising that partitioning of organochlorines between bone and other tissues remain to be elucidated and considering whether data were corrected for recovery. Where studies did not discuss correction for recovery, it was assumed that data were not corrected.

Scheele and coworkers reported hexachlorobenzene levels in bone marrow of 186ng/g lipid (3), elevated in comparison to the mean data from bone detected in this study. Samples of adipose tissue from Turkish subjects (mean 164ng/g lipid)(4), Poles (mean 260ng/g lipid)(5) and Spanish men (mean 2470ng/g lipid)(1) also contained higher concentrations than those determined in the current study.

Alpha-HCH was not detected in any samples in the current study, although it has been reported in adipose tissue of people from Poland (mean 7ng/g lipid)(5), Turkey (mean 14ng/g lipid)(4) and Spain (mean 460ng/g lipid in male subjects)(1). Conversely, gamma-HCH (lindane) was only detectable in 2 out of 60 subjects in the Turkish study whereas it was detectable in all samples from Ireland and the UK. There was no significant difference between concentrations of alpha and gamma-HCH in Poland (5). This difference is probably attributable to use of technical HCH rather than lindane in some regions.

DDE is usually found in greater concentrations in human samples than other pollutants. The concentration found by Scheele and coworkers in bone marrow (1690ng/g lipid)(3) was at the high end of those found in the present study. In studies of adipose tissue, higher concentrations were found in Japan (mean 2400ng/g lipid)(6), Spain (mean for males 2830ng/g lipid)(1), Turkey (mean 3720ng/g lipid)(4) and Poland (mean 15000ng/g lipid)(5). Concentrations in adipose tissue of Italian men were lower than those found in this study (mean 351ng/g lipid)(2). TDE was detected in only one sample and DDT was detected in none. DDT has previously been detected in Italian (mean 67ng/g lipid for males)(2), Turkish (mean 320ng/g lipid)(4) and Polish (mean 670ng/g lipid)(5) adipose samples. TDE was detected in 40% of Italian males sampled (mean 48ng/g lipid)(2). As with the HCH isomers, this probably reflects regional use patterns.

Duarte-Davidson and coworkers (7) conducted congener-specific PCB analyses on human adipose tissues from Wales, UK. The sum of individual congeners (mean 865ng/g lipid) appears slightly higher than for the UK samples reported here, though comparison is complicated because different groups of congeners were analysed. German adipose tissue, analysed for a very similar group of congeners to this study, contained lower concentrations, though they were in the same general range (8). Total PCB concentrations in adipose tissue from Poland (mean 1500ng/g lipid)(5) were similar to those obtained for Ireland and the UK. However, the concentrations reported here are lower than those in adipose tissues from Arctic peoples with high intakes of traditional foodstuffs (matched PCB 16900ng/g lipid)(9).

In conclusion, it appears that concentrations of the organochlorines measured in human bone lipid in this study are of a similar magnitude to those reported for other human tissue samples. It is

difficult to compare the data closely due to a lack of data from other studies on bone, regional variations in chemical use, differing exposure patterns and inter-laboratory analytical differences. This study is continuing.

References

1. Ferrer A, Bona MA, Castellano M, To-Figueras J and Brunet M; Bull. Environ. Contam. Toxicol. **1992**, 48, 561-566

2. Gallelli G, Mangini S and Gerbino C; J. Toxicol. Environ. Health **1995**, 46, 293-300

3. Scheele J, Teufel M and Niessen KH; Arch. Environ. Health **1996**, 51(1), 22-25

4. Burgaz S, Afkham BL and Karakaya AE; Bull. Environ. Contam. Toxicol. **1994**, 53, 501-508

5. Tanabe S, Falandysz J, Higaki T, Kanna K and Tatsukawa R; Environmental Pollution **1993**, 79, 45-49

6. Sasaki K, Ishizaka T, Suzuki T, Takeda M and Uchiyama M; Bull. Environ. Contam. Toxicol. **1991**, 46, 662-669

7. Duarte-Davidson R, Harrad S, Allen S, Sewart A and Jones KC; Arch. Environ. Contam. Toxicol. **1993**, 24, 100-107

8. Kannan N, Schulz-Bull DE, Petrick G, Duinker JC, Macht-Hausmann M and Wasserman O; Arch. Environ. Health **1994**, 49(5), 375-383

9. Dewailly E, Hansen JC, Pedersen HS, Mulvad M, Ayaotte P, Weber JP and Lebel G; Organohalogen Compounds **1995**, 26, 175-180

	IRELAND				UNITED KINGDOM			
	Mean (SD)	**Range**	**%Rec**	**LOD**	**Mean (SD)**	**Range**	**%Rec**	**LOD**
AGE	69.0 (7.5)	58-79	-	-	70.9 (9.0)	60-82	-	-
HCB	72.1 (40.0)	45-159	69	2	43.6 (13.8)	26-74	66	2
A-HCH	n/d (-)	-	67	5	n/d (-)	-	67	3
G-HCH	15.8 (8.6)	5-29	64	3	10.9 (12.0)	4-37	62	2
p,p'-DDE	966 (529)	273-1654	75	4	678 (319)	243-1136	92	3
p,p'-TDE	n/d (-)	-	69	2	n/d (-)	-	63	1
p,p'-DDT	n/d (-)	-	88	2	n/d (-)	-	80	1

Table 1. Concentrations of organochlorine pesticides in bone. Ages of subjects are in years. Concentrations are given in ng/g on a lipid basis. n/d: not detected; %Rec: mean % recovery; LOD: limit of detection in ng/g based on mean sample weight.

	IRELAND				UNITED KINGDOM			
	Mean (SD)	Range	%Rec	LOD	Mean (SD)	Range	%Rec	LOD
AGE	69.0 (7.5)	58-79	-	-	70.9 (9.0)	60-82	-	-
PCB 8	n/d (-)	-	88	3	n/d (-)	-	86	2
PCB 18	n/d (-)	-	88	17	n/d (-)	-	85	13
PCB 28	n/d (-)	-	92	9	n/d (-)	-	87	7
PCB 31	n/d (-)	-	95	2	n/d (-)	-	87	2
PCB 52	n/d (-)	-	103	17	n/d (-)	-	108	13
PCB 77	18.3 (55.0)	n/d -165	93	2	n/d (-)	-	82	2
PCB 101	13.6 (28.7)	n/d -81	95	2	n/d (-)	-	84	2
PCB 105	12.7 (27.5)	n/d -84	89	2	1.4 (1.5)	nd-3	80	1
PCB 114	13.2 (18.2)	n/d -59	93	2	14.9 (2.9)	11-19	84	1
PCB 118	27.6 (22.8)	11-70	96	0.8	16.1 (5.1)	10-26	88	0.6
PCB 123	8.7 (26.0)	n/d –78	96	2	1.0 (1.9)	nd-5	84	1
PCB 126	3.1 (6.9)	n/d –20	91	2	1.3 (1.8)	nd-4	82	2
PCB 128	n/d (-)	-	88	1	1.5 (2.8)	nd-7	80	0.8
PCB 138	95.0 (43.0)	43-169	102	1	72.9 (19.5)	46-98	105	1
PCB 149	n/d (-)	-	91	1	n/d (-)	-	82	0.8
PCB 153	214 (92.8)	106-350	105	2	160 (36.3)	105-209	106	1
PCB 156	50.9 (37.9)	21-140	88	2	27.6 (5.8)	18-36	82	2
PCB 157	14.1 (38.7)	n/d -117	89	2	3.0 (4.2)	nd-10	80	2
PCB 167	6.1 (18.3)	n/d -55	99	0.8	1.4 (1.7)	nd-5	87	0.6
PCB 169	27.8 (28.1)	7-89	105	1	15.1 (8.5)	8-35	97	0.8
PCB 170	47.0 (30.9)	19-105	90	0.7	34.6 (6.8)	22-42	88	0.5
PCB 180	140 (78.2)	63-256	103	0.9	108 (24.4)	68-137	110	0.7
PCB 209	22.6 (45.8)	n/d -143	90	3	4.6 (1.4)	3-6	82	2.0
SUM PCB	715 (482)	334-1813	-	-	463 (98.5)	303-583	-	-
PCB matched	1680 (604)	941-2600	-	-	1510 (333)	976-1910	-	-
PCB total	1930 (663)	993-2810	-	-	1660 (348)	1020-2090	-	-

Table 2. Concentrations of PCBs in bone. Ages of subjects are in years. Concentrations and detection limits are given in ng/g on a lipid basis. %R: mean % recovery; LOD: limit of detection (ng/g) based on mean sample weight; n/d: not detected; SUM PCB: total of all individually identified congeners; PCB matched: total of all PCB peaks matched to a PCB 1254 standard; PCB total: total of all PCB peaks identified.