CONCENTRATIONS OF POLYCHLORINATED BIPHENYLS IN BLOOD OF YUSHO PATIENTS COLLECTED FROM MEDICAL CHECK-UPS IN 2010

Miyawaki T[1]*, Hori T[1], Todaka T[2], Hirakawa H[1], Kajiwara J[1], Hirata T[1], Uchi H[2,3], Furue M[2,3]

[1]Fukuoka Institute of Health and Environmental Sciences, Fukuoka, Japan; [2]Department of Dermatology, Graduate School of Medical Sciences, Kyusyu University, Fukuoka, Japan; [3]Research and Clinical Center for Yusho and Dioxin,Kyushu University Hospital, Fukuoka, Japan.

Introduction

Over 40 years have passed since the Yusho outbreak, which occurred because Yusho patients had ingested rice oil contaminated with large amounts of PCBs that were used as a heat-transfer medium in the process of rice oil production. Survey studies on the concentrations of PCB congeners in the blood of Yusho patients are very important when considering the health status of these patients. The data from congener profiles regarding PCBs in the blood of Yusho patients may provide us with newly important information related to exposure evaluation of patients and with valuable information for future epidemiologic studies. In this study, we carried out a congener-specific analysis of PCBs in the blood collected from Yusho patients during medical check-ups performed in 2010. We compared with the concentrations of PCB congeners between this study and the results obtained from Yusho patients and normal controls during medical check-ups performed in 2005.

Materials and methods

Sampling

Medical check-ups for Yusho patients have been conducted annually to determine the health status of patients since the outbreak of the Yusho incident. The blood samples examined in this study were collected from 230 participants who received a medical check-up in 2010. Informed consent was obtained from all participants. The mean age of Yusho patients in 2010 was 68.3 years. Additionally, that of Yosho patients and nomal controls in 2005 was 67.3 and 68.1 years, respectively.

Blood samples of 10 ml were collected using a vacuum blood collecting tube containing heparin and were stored at 4°C until analyses for congener concentrations of PCBs.

Analysis

The extraction and purification of PCB congeners from the blood samples was performed using a previously reported method[2)-3)]. Briefly, the extraction of lipid from each 5 g blood samples was performed with an accelerated solvent extractor (ASE) system, and the extract was refined with concentrated sulfuric acid, a silver nitrate silica gel column, an activated carbon dispersed silica gel column and sulfoxide cartridge column as a further clean-up.

Congener-specific analysis of PCBs was measured using a high resolution gas chromatography / high resolution mass spectrometry (HRGC/HRMS). The measurement conditions were as follows: the gas chromatograph was an HP-6890A (Agilent Technologies, USA) equipped with an Autospec Ultima NT, (Micromass Ltd., UK); the column used was a HT8-PCB fused silica precapillary column, 0.25 mm i.d.×60 m (SGE Ltd.); The column oven temperature of the HT8-PCB was programmed at a rate of 20°C min^{-1} from an initial temperature of 130°C (1 min hold) to a temperature of 220°C, then at a rate of 3°C min^{-1} to a temperature of 280°C, then at a rate of 20°C min^{-1} to a final temperature of 300°C (3.5 min hold). The carrier gas of helium flow rate (constant flow) was 1.3 ml/min. The injection temperature was maintained at 270°C and each sample (2 µl) was injected in the splitless mode. The ionizing energy, accelerating voltage, and trap current were 40 eV, 8.0 kV and 750 µA, respectively. Analysis was performed using EI ionization and selected ion monitoring mode. The resolution was maintained at 10000 at 5% valley.

Results and discussion

The concentrations of PCB congeners in the blood of Yusho patients from 2005 to 2010, including the dates of the normal controls that had been previously reported, are presented in Table 1. Among the PCB congeners that were measured in the present study, hexaCB-138, hexaCB-153, heptaCB-180, and heptaCB-182/ heptaCB-187

showed high ratios to the total concentrations of PCB congeners detected in the blood of Yusho patients and normal controls.

Table 1 Comparison of PCB concentrations in blood collected from medical check-ups.

	Concentration (pg g^{-1} lipid)					
	Yosho patients				Normal controls	
	2005 (n=237)		2010 (n=230)		2005 (n=127)	
IUPAC#	Mean	S.D.	Mean	S.D.	Mean	S.D.
245-TrCB (#29)	32	39	332	964	25	18
244'-TrCB (#28)	1371	1363	2794	4680	2571	1651
344'-TrCB (#37)	19	91	533	1058	-	-
22'55'-TeCB (#52)	977	1628	1186	910	1290	828
22'45'-TeCB (#49)	235	411	279	192	303	127
22'44'-TeCB (#47)	438	560	542	440	605	214
22'35'-TeCB (#44)	312	604	401	284	458	174
23'4'6-TeCB (#71)	87	263	47	56	192	73
234'5-TeCB (#63)	84	87	165	126	146	88
244'5-TeCB (#74)	9835	9047	15384	12708	19472	10764
23'4'5-TeCB (#70)	197	468	289	197	259	98
23'44'-TeCB (#66)	1514	1566	2392	2191	2338	1820
233'4'-/2344'TeCBs (#56/60)	489	538	366	305	884	703
22'35'6-PeCB (#95)	667	974	762	409	833	406
22'355'-PeCB (#92)	601	713	856	678	860	661
22'455'-PeCB (#101)	1680	1903	2070	1458	1898	1231
22'44'5-PeCB (#99)	17682	19558	19515	14223	12505	6771
234'56-PeCB (#117)	1401	2384	1777	1843	927	678
22'345'-PeCB (#87)	646	783	1061	665	692	378
22'344'-PeCB (#85)	142	183	246	285	218	142
233'4'6-PeCB (#110)	365	452	468	353	411	176
233'4'5-PeCB (#107)	693	532	1183	992	987	755
2'344'5-PeCB (#123)	276	244	343	343	466	328
23'44'5-PeCB (#118)	16343	14096	25272	21359	24353	14654
2344'5-PeCB (#114)	1895	1830	2921	2898	1697	823
233'44'-PeCB (#105)	3473	3092	4786	3904	5061	3378
22'355'6-HxCB (#151)	1254	1301	1442	1123	1255	935
22'33'56'-HxCB (#135)	470	474	538	361	475	290
22'34'56-HxCB (#147)	612	590	757	562	484	316
22'344'6-HxCB (#139)	742	915	235	299	822	476
22'33'56-HxCB (#134)	25	41	12	30	27	31
233'55'6-HxCB (#165)	1412	5649	13	62	-	-
22'34'55'-HxCB (#146)	21873	18704	31671	24057	13899	6679
22'33'46'-HxCB (#132)	188	296	292	250	282	170
22'44'55'-HxCB (#153)	134448	114863	185274	146424	89821	40509
22'3455'-HxCB (#141)	303	289	351	281	324	201
22'344'5-HxCB (#137)	6019	7872	7670	6452	2968	1407
22'33'45'-HxCB (#130)	4466	5476	5749	4735	2620	1557
233'4'5'6-HxCB (#164)	27083	24373	45856	35944	19350	9773
22'344'5'-HxCB (#138)	66117	66121	79510	61053	40872	19530
22'33'44'-HxCB (#128)	865	744	1104	843	876	506
23'44'55'-HxCB (#167)	3927	3280	6092	5490	3649	1853
233'44'5-HxCB (#156)	30958	41361	39262	39620	7982	3729
233'44'5'-HxCB (#157)	8418	11945	9624	10575	2024	910
22'33'566'-HpCB (#179)	219	229	236	200	208	134
22'33'55'6-HpCB (#178)	9511	8814	15320	15837	6248	3120
22'344'56-HpCB (#182/187)	43375	41432	62745	64135	28083	13934
22'344'5'6-HpCB (#183)	10460	10400	12059	10758	6145	3037
22'344'56-HpCB (#181)	315	574	329	396	71	45
22'33'4'56-HpCB (#177)	8533	8303	12661	10269	5753	3071
22'33'455'-HpCB (#172)	5948	5463	8806	7943	2974	1519
22'344'55'-HpCB (#180)	110380	103290	170202	165050	59481	30223
233'44'5'6-HpCB (#191)	1813	2113	2344	1960	766	369
22'33'44'5-HpCB (#170)	39700	36914	52072	44967	17268	8718
233'44'55'-HpCB (#189)	4542	5026	5799	5528	1052	520
22'33'55'66'-OcCB (#202)	4547	4434	5356	4981	2812	4472
22'33'45'66'-OcCB (#200)	663	698	576	541	648	1389
22'33'4566'-OcCB (#201/198)	25584	24142	14255	14967	10093	5652
22'344'55'6-OcCB (#203)	19357	17408	13968	12703	7820	4132
22'33'44'56-OcCB (#195)	4389	4031	5013	4362	1820	943
22'33'44'55'-OcCB (#194)	19132	17766	27038	27510	8595	5122
233'44'55'6-OcCB (#205)	873	822	826	687	309	138
22'33'455'66'-NoCB (#208)	948	700	1639	1237	775	375
22'33'44'566'-NoCB (#207)	414	329	654	493	339	176
22'33'44'55'6-NoCB (#206)	3088	2387	4291	3061	1960	890
22'33'44'55'66'-DeCB (#209)	1153	1016	2227	1633	1361	541
Total TrCBs	1407	1360	3659	5419	2596	1651
Total TeCBs	14169	12055	21050	14665	25961	13479
Total PeCBs	42514	35408	61260	40764	51021	28230
Total HxCBs	308929	278907	411841	302748	187798	85166
Total HpCBs	234795	212850	342573	317681	128048	63336
Total OcCBs	74546	67572	67032	64633	32096	18606
Total NoCBs	4450	3357	6583	4695	3075	1404
Total PCBs	652325	581942	911119	705977	431955	199603

S.D.: standard deviation
-: not detected

Among the 209 PCB congeners, 8 congeners of mono-*ortho* PCBs and 58 congeners of non-dioxin-like PCBs were identified in the blood of Yusho patients. Among the PCB congeners measured in the present study, hexaCB-153, hexaCB-138, heptaCB-180, and heptaCB-182/heptaCB-187 showed high ratios to total concentrations of PCB congeners detected in the blood of Yusho patients, and the profiles of the major congeners were the same as those obtained in normal controls.

The total concentrations of PCB congeners in the blood of Yusho patients from 2005 to 2010 were 652 and 911 ng g^{-1} lipid for each year, respectively, and the concentrations were 1.5 and 2.1 times higher than those of normal controls for each year, respectively. The ratios of heptachlorinated biphenyls (heptaCBs) to the total concentrations of PCB congeners in the blood of Yusho patients from 2005 to 2010 tended to be slightly higher than those in the normal controls. The concentrations of hexaCB-156, hexaCB-157, heptaCB-181, and heptaCB-189 in the blood samples for Yusho patients were 31, 8.4, 0.3, and 4.5 ng g^{-1} lipid in 2005, respectively, 39, 9.6, 0.3, and 5.8 ng g^{-1} lipid in 2010, respectively. As the results comparing the concentrations of PCB congeners in the blood between Yusho patients and normal controls, the concentrations of hexaCB-156, hexaCB-157, heptaCB-181, and heptaCB-189 for Yusho patients were 3.9, 4.2, 4.4, and 4.3 times, respectively, 4.9, 4.7, 4.6, and 5.5 times, respectively, higher than those of the normal controls for each year from 2005 to 2010, respectively. These results indicated that Yusho patients still have higher concentrations of hexaCB-156, hexaCB-157, heptaCB-181, and heptaCB-189 in their blood than do unaffected people, even though over 40 years have passed since the outbreak of Yusho. These four congeners can therefore be considered to be the most important congeners for evaluating the PCBs exposure of Yusho patients.

Acknowledgements

This work was supported in part by a Grant-in-Aid for scientific research from the Ministry of Health Labour and Welfare, Japan.

References:

1. Todaka T, Hori T, Yasutake D, Yoshitomi H, Hirakawa H, Onozuka D, Kajiwara J and Iida T (2009) *Fukuoka Igaku Zasshi* 100 : 156-165
2. Todaka T,Hirakawa H,Tobiishi K and Iida T (2003) *Fukuoka Igaku Zasshi* 94 : 148-157
3. Hori T, Tobiishi K, Ashizuka Y, Nakagawa R, Todaka T, Hirakawa H and Iida T (2005) *Fukuoka Igaku Zasshi* 96 : 220-226