SEMEN QUALITY AND SERUM ORGANOCHLORINE LEVELS

Susan Korrick[1,2], Larisa Altshul[2], Boris Revich[3], Tsiliya Bobovnikova[4], Galina Chernik[4]

[1]Channing Laboratory, Department of Medicine, Brigham and Women's Hospital, 181 Longwood Ave., Boston, MA 02115, U.S.A.
[2]Department of Environmental Health, Harvard School of Public Health, 665 Huntington Ave., Boston, MA 02115, U.S.A.
[3]Center of Demography and Human Ecology, Russian Academy of Sciences, 47 Nachimovksi Ave., Moscow 117418, Russia.
[4]Typhoon Laboratory, 82 Lenin St., Obninsk, Kaluga Region 249020, Russia.

Introduction

Polychlorinated biphenyls (PCBs) and metabolites of the organochlorine pesticide DDT are widely occurring environmental contaminants to which the general population has been routinely exposed. Much of the industrial world banned the use of PCBs and DDT over the past 25+ years, but, because of their refractory nature, significant exposures still occur and are expected to continue for decades.

PCBs, DDT, and DDT's primary metabolite, dichlorodiphenyl dichloroethene (p,p-DDE) have been associated with male reproductive failure in wildlife and/or with impaired reproductive development in animal models.[1] Higher seminal fluid PCB levels have been associated with lower sperm motility among men with low sperm counts.[2] Prenatal PCB exposure during the 1979 rice oil poisoning episode in Taiwan was associated with poor semen quality including increased abnormal morphology, and reduced motility and oocyte penetration capacity among young adults.[3] Higher seminal fluid PCB levels have been observed among infertile than fertile men and, among infertile men, have been associated with lower total motile sperm counts.[4] The aim of the current study is to assess the hypothesized association of PCBs and DDE with semen quality in a sample of men residing in a PCB-contaminated town in Russia.

Material and Methods

Study participants are a subset of men (n = 35) participating in a case-control study (62 infertile and 63 fertile couples) of PCBs and infertility conducted between 1997 and 1998 in Serpukhov, Russia.[5] Residents of Serpukhov, an industrial community near Moscow with a population of approximately 142,000, were chosen for study because of the town's history of PCB contamination from a local capacitor manufacturing plant. This manufacturing facility used approximately 1400 tons of PCBs annually between the 1960s and 1988.[6] The facility's effluent and run-off from a nearby PCB storage site were sources of PCB contamination in the community, including areas where local food crops and livestock were produced.[6]

In the parent case-control study, couples with primary infertility were recruited for study from a local infertility clinic after excluding those with acquired disease (secondary to infection, for example). The parent study evaluation included administration of a detailed medical, reproductive, and exposure history questionnaire to ascertain risk factors for infertility and PCB exposure.

Whole blood samples were obtained during the case-control study evaluation and analyzed for 52 PCB congeners (including co-eluting congener pairs for PCBs 24/27, 28/31, 66/95, 77/110, 149/118, and 171/156) and dichlorodiphenyl dichloroethene (p,p'-DDE) at Typhoon Laboratory, Obninsk,

Russia. Serum from these samples was extracted using a U.S. Centers for Disease Control and Prevention method modified for ultra trace level analysis.[7] The sample extracts were analyzed by gas chromatography with electron capture detection (GC/ECD) using a Hewlett-Packard 5870A GC with a capillary column. Quantitation was based on the response factor of individual PCB congeners relative to the internal standard (PCB 166). Serum percent lipid content was determined gravimetrically. Final concentrations were reported after subtracting the amount of analyte measured in the procedural blank associated with the analytic batch. PCB concentrations were reported as individual congeners and the sum of all congeners assayed (ΣPCB) in units of ng/g lipid.

Semen analysis is not a routine component of clinical infertility assessment in Serpukhov, and some men reportedly do not have the test because of cultural or personal objections. Of 62 infertile couples participating in the parent case-control study, semen analyses were available for 35 (56%) as part of their clinical evaluation for infertility. These 35 men are included in the current analysis. Semen analyses were performed between 1995 and 1998. Results of these semen analyses were obtained by medical record review. Documentation of the specific methods used to perform these semen analyses was not available.

The World Health Organization guidelines[8] were used to define low sperm counts (< 20 million/ml) and low sperm motility (< 50%). Total motile sperm count was defined as sperm concentration times the percent motile sperm. Sperm morphology assessments using strict or standardized criteria were not available for the study participants. Serum PCB and DDE levels were approximately log normally distributed so natural log transformed values were used in these analyses. The Wilcoxon Rank Sum Test (t-test approximation) was used to compare serum PCB and DDE levels according to dichotomized measures of semen quality and to compare semen quality measures according to demographic and lifestyle characteristics.

Results

Age, duration of infertility, and exposure measures were similar for men with semen samples included in this analysis and those without semen samples (Table 1). In addition, these two groups did not differ significantly with regard to smoking, alcohol intake, education, income, or other covariates such as history of genitourinary infection.

Table 1. Characteristics of Men in Infertile Couples With and Without Semen Analyses

	Mean (SD)			
	Age @ study	Years Infertile	DDE (ng/g fat)*	3PCB (ng/g fat)*
With Semen, n=35	28.9 (5.2)	2.1 (0.9)	7.0 (0.7)	6.4 (0.6)
Without Semen, n=27	29.5 (5.6)	2.3 (1.7)	7.2 (0.9)	6.3 (0.4)

(*natural log transform)

Among the 35 participants in this analysis, 57% were current smokers and the majority (63%) had some college education. The median alcohol consumption was 2 drinks per week.

There were no significant differences in serum DDE or PCB levels among men with higher sperm counts, better sperm motility, or higher concentrations of motile sperm than those with poor profiles for these measures (Table 2). The lack of an association of PCBs with measures of semen quality was consistent across individual PCBs congeners (Table 2).

Table 2. Serum PCB and DDE Levels According to Semen Parameters

	Mean (SD) (ng/g lipid)*				
	DDE	ΣPCB	PCB153	PCB149/118	PCB28/31
Sperm Concentration (10^6/ml)					
>20 (n = 27)	7.0 (0.7)	6.3 (0.6)	4.4 (0.6)	3.8 (1.2)	3.1 (0.8)
<20 (n = 8)	6.7 (0.3)	6.5 (0.8)	4.6 (0.5)	4.0 (0.7)	3.1 (1.6)
%Motile sperm					
>50 (n = 28)	7.0 (0.7)	6.4 (0.6)	4.4 (0.6)	3.9 (1.2)	3.1 (1.1)
<50 (n = 6)	6.8 (0.4)	6.3 (0.5)	4.5 (0.6)	3.7 (0.5)	3.0 (0.6)
Motile sperm (10^6 /ml)					
31-99 (n = 17)	7.2 (0.8)	6.5 (0.6)	4.5 (0.6)	4.2 (0.9)	3.1 (0.8)
0.4-28 (n = 17)	6.8 (0.5)	6.3 (0.6)	4.4 (0.6)	3.5 (1.3)	3.1 (1.2)

(*natural log transform of all DDE and PCB measures)

There were no significant associations of measures of semen quality with age, alcohol consumption, or smoking in these analyses. However, among five men with reported occupational exposures to lead and/or ionizing radiation, total sperm concentrations and motile sperm concentrations were significantly lower than among non-occupationally exposed men (21.5 vs. 49 million/ml, p = 0.01 and 13 vs. 35 million/ml, p = 0.03, respectively). The percent of motile sperm was also lower among those with occupational lead or ionizing radiation exposure than among non-occupationally exposed men although this difference was not statistically significant (56% vs. 67%, p = 0.13).

Discussion

We did not find an association of serum PCB or DDE levels with measures of semen quality in this study of male partners in infertile couples. However, the study was limited by small sample size and incomplete semen parameters. For example, semen counts may not be as sensitive to subtle toxicant effects as other measures such as sperm morphology that were not available for analysis. Furthermore, we did not have documentation of the methods used for semen analyses so variability in semen analysis technique may have contributed to outcome misclassification and further reduction in the study's sensitivity for the detection of small effects.

We did not see associations of semen quality with age, alcohol consumption, or smoking, correlates of semen quality observed in some previous studies.[9,10] This may reflect the young age distribution and relatively modest alcohol consumption patterns of the study men, small sample size, and potential semen parameter misclassification. However, despite small numbers, there were associations of semen parameters with a history of occupational lead or ionizing radiation exposure suggesting that our semen data were sensitive to other exposure measures associated with semen quality elsewhere.[9]

Given animal and limited human data suggesting the potential for male reproductive disruption, including changes in semen parameters, by exposure to PCBs, DDE, and related compounds, larger studies with more extensive semen analyses are warranted.

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