Brief Communication

Serum organochlorine pesticide levels in patients with metabolic syndrome

Laxmikant R. Tomar, Mukul P. Agarwal, Rajnish Avasthi, Vipin Tyagi[1], Mohammad Mustafa[1], B. D. Banerjee[1]

Departments of Medicine, [1]Biochemistry, University College of Medical Sciences and Guru Teg Bahadur Hospital, University of Delhi, Delhi, India

ABSTRACT

Introduction: Organochlorine pesticides (OCPs) are endocrinal disruptors that tend to accumulate in adipose tissue and have been found to be associated with Metabolic Syndrome (MS). **Aim and Objectives:** 1. To measure serum OCP levels in patients of MS and control subjects, 2. To identify differences, if any, in serum OCP levels, in patients with MS and control subjects. **Materials and Methods:** Cross-sectional study was conducted in the Departments of Medicine and Biochemistry at University College of Medical Sciences (UCMS) and Guru Teg Bahadur Hospital (GTBH), Delhi. Nine OCPs [α-HCH (Hexachlorocyclohexane), β-HCH, γ-HCH, α-endosulfan, β-endosulfan, aldrin, dieldrin, *p, p'*-DDT (Dichloro-diphenyl-trichloro-ethane), and *p, p'*-DDE (Dichloro-diphenyl-dichloro-ethylene)] were studied. Fifty subjects ≥18 years with MS (study group) and 50 age and sex-matched controls were included in the study. Exclusion criteria: (1) Persons having chronic occupational exposure to OCPs such as workers of pesticide factories, (2) Recent exposure to OCPs within 4 weeks. **Results:** Levels of all nine OCPs were higher in cases as compared to controls. However, only the mean value of β-HCH in cases (8.40 ± 8.64 ng/ml) was significantly ($P < 0.001$) higher as compared to controls (2.58 ± 2.34 ng/ml). After adjustment of confounding factors like age, sex, smoking, alcohol, and body mass index (BMI), only β-HCH and aldrin levels were positively and significantly associated with the risk of having MS. Adjusted Odds Ratio (OR) was 1.34 [CI = 1.14–1.57 ($P < 0.001$)] and 1.23 [CI = 1.01–1.50 ($P = 0.045$)], respectively. **Conclusion:** There was a significant association of β-HCH and aldrin levels with MS.

Key words: Aldrin, β-Hexachlorocyclohexane, metabolic syndrome, organochlorine pesticides

Introduction

Metabolic syndrome (MS) is a group of risk factors including hypertension, hyperglycemia, hypertriglyceridemia, low high density lipoprotein (HDL) cholesterol, and central obesity. Organochlorine pesticides (OCPs) are a group of Persistent Organic Pollutants such as Hexachlorocyclohexane (HCH) and its isomers, aldrin, dieldrin, α-endosulfan, β-endosulfan, *p, p'*- Dichloro-diphenyl-trichloro-ethane (DDT), and *p, p'*- Dichloro-diphenyl-dichloro-ethylene (DDE). Humans are exposed to pesticides by different routes such as inhalation, ingestion, and dermal contact.[1] OCPs are endocrine disrupting chemicals stored in adipose tissue because of their persistence in the environment and high bioaccumulative nature.[2] OCPs have also been shown to have a strong association with insulin resistant type 2 diabetes.[3-5] Only a few earlier studies have revealed an association between OCPs and MS.[6]

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Aim

- To measure serum OCP levels in patients of MS and control subjects.
- To identify differences, if any, in serum OCP levels, in patients with MS and control subjects.

Corresponding Author: Dr. Laxmikant R. Tomar, Department of Medicine, University College of Medical Sciences and Guru Teg Bahadur Hospital, University of Delhi, Dilshad Garden, Delhi - 110 095, E-mail: drlaxmikantucms@yahoo.com

Materials and Methods

Cross-sectional study was conducted in the Departments of Medicine and Biochemistry at University College of Medical Sciences (UCMS) and Guru Teg Bahadur (GTB) Hospital, Delhi. For identification of MS, we used National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP)-III criteria modified as per International Diabetes Federation (IDF) (hypertension ≥130/≥85 mmHg or on medication, fasting plasma glucose ≥110 mm/dL or on medication, HDL cholesterol <40 mg/dL (men) or <50 mg/dL (women), plasma triglycerides (TGs) ≥150 mg/dL or on medication, waist circumference ≥90 cm for males and ≥80 cm for females). There were a total of 100 subjects divided into two groups. Group I: Fifty individuals ≥18 years, with MS (study group) and Group II: 50 individuals with age and sex matched controls. Serum OCPs were measured and the levels in the two groups were compared.

Exclusion criteria

- Persons having chronic occupational exposure to OCPs such as workers of pesticide factories,
- Recent exposure to OCPs within 4 weeks

Waist circumference was measured midway between the inferior margin of rib cage and iliac crest. Plasma glucose was analyzed using glucose oxidase/peroxidase method. The blood pressure was measured after a 5 min rest in the right arm in the supine position. Three readings were taken at 5 min intervals and their mean was taken as the final reading. Blood was drawn after 8 hours of overnight fasting. Total cholesterol and triglycerides was estimated by enzymatic method. HDL cholesterol was estimated in serum by turbidimetric immunoassay. Serum very low density lipoprotein (VLDL) was estimated by using the formula VLDL = TG/5. Serum low density lipoprotein (LDL) was determined from the Friedewald's formula, LDL = total cholesterol-(HDL + VLDL). OCPs were extracted according to method of Bush *et al*.[7] Quantification of OCP levels was done by Perkin Elmer GC equipped with 63Ni selective electron capture detector. The limit of detection (LOD) was 4 picogram/mL (pg/mL) for each OCP.

Statistical analysis

The data for all the groups was expressed as mean ± standard deviation. The physical, biochemical parameters and levels of OCPs in cases and controls were compared by independent *t*-test. Risk of having MS with OCPs was calculated by using logistic regression analysis.

Results

Table 1 shows data for waist circumference, body mass index (BMI), blood pressure, fasting blood glucose, HDL, and TGs of both cases and controls.

Although, OCP levels of cases were higher as compared to controls but only in case of β-HCH the mean value (8.40 ± 8.64 ng/ml) was significantly ($P < 0.001$) higher as compared to controls (2.58 ± 2.34 ng/ml). Table 2 shows the data for levels of all nine OCPs.

After adjusting for confounding factors like age, sex, smoking, alcohol, and BMI, β-HCH as well as aldrin showed an association with MS. Adjusted Odds Ratio (ORs) for β-HCH and aldrin were 1.34 (95% CI = 1.14–1.57) and 1.23 (95% CI = 1.01–1.50), respectively. Table 3 shows the risk of having MS with all nine OCPs after adjustment of confounders.

Discussion

In our study, mean serum levels of all nine OCPs were higher in cases as compared to controls. Mean level of

Table 1: Physical and biochemical data for cases and controls

Parameters	Mean±SD (*n*=50)		*P* value*
	Cases	Controls	
Waist circumference (cm)	99.94±12.12	88.66±8.19	<0.001*
Blood pressure (mmHg)			
SBP	145.40±18.69	118.64±9.45	<0.001*
DBP	84.08±8.50	75.08±6.97	<0.001*
Fasting blood glucose (mg/dl)	122.74±39.49	81.36±7.62	<0.001*
HDL cholesterol (mg/dl)	35.64±8.08	42.98±7.33	<0.001*
Triglyceride (mg/dl)	208.30±92.68	82.66±14.34	<0.001*

*independent *t* test, *P*<0.05 is statistically significant, SD: Standard deviation

Table 2: Levels of organochlorine pesticide in cases and controls

OCPs (ng/ml)	Mean±SD (*n*=50)		*P* value*
	Cases	Controls	
α-HCH	2.93±5.42	2.77±1.09	0.832
β-HCH	8.40±8.64	2.58±2.34	<0.001*
γ-HCH	2.34±5.40	1.69±1.44	0.414
α-endosulfan	1.80±4.20	1.46±1.34	0.587
β-endosulfan	1.41±1.47	1.26±1.34	0.618
p, p'-DDE	2.32±3.26	1.94±1.74	0.467
p, p'-DDT	1.62±1.43	1.44±1.14	0.477
Aldrin	3.46±5.20	2.08±2.19	0.087
Dieldrin	2.22±3.51	2.07±1.40	0.773

*independent *t* test, *P*<0.05 is statistically significant, SD: Standard deviation, HCH: Hexachlorocyclohexane, DDE: Dichloro-diphenyl-dichloro-ethylene, DDT: Dichloro-diphenyl-trichloro-ethane

Table 3: Risk of metabolic syndrome with OCPs

OCP	Odds ratio	95% confidence Interval		*P* value*
		Lower	Upper	
α-HCH	1.07	0.92	1.26	0.370
β-HCH	1.34	1.14	1.57	<0.001*
γ-HCH	1.02	0.79	1.32	0.886
α-endosulfan	0.975	0.81	1.17	0.781
β-endosulfan	0.99	0.67	1.49	0.985
p, p'-DDE	1.01	0.81	1.26	0.928
p, p'-DDT	1.02	0.65	1.59	0.945
Aldrin	1.23	1.01	1.50	0.045*
Dieldrin	1.02	0.81	1.27	0.901

*Logistic regression analysis (with adjustment for age, sex smoking, alcohol), *P*<0.05 is statistically significant, SD: Standard deviation, HCH: Hexachlorocyclohexane, DDE: Dichloro-diphenyl-dichloro-ethylene, DDT: Dichloro-diphenyl-trichloro-ethane

β-HCH in cases was significant higher ($P < 0.001$). After adjustment for confounding factors the risk of having MS with β-HCH in study group was found to be 1.34 times higher as compared to control group ($P < 0.001$). β-HCH is the most persistent OCP still in use in developing countries like India and China.[8] It is more persistent and more slowly cleared from the body than other isomers, and is, therefore, the easiest isomer to detect in humans and is most likely to affect individual health chronically.[9] Similarly, risk of developing MS with exposure to aldrin was 1.23 times higher as compared to controls ($P = 0.045$). Aldrin is an OCP which was widely used in agriculture and public health programs in India. Because of low water solubility and tendency to bind strongly to soil, aldrin migrates downwards very slowly through soil, or into surface or ground water (ATSDR 2002).[10] This pesticide may also be associated with adverse neurological and reproductive effects.

Conclusion

The results of our study suggest that background environmental exposure to some OCPs, especially β-HCH and aldrin, may be involved in the pathogenesis of metabolic syndrome. This highlights the need for active interventions on a national scale restricting the use of OCPs and there replacement by safer and environment friendly alternatives.

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