Lower omega-3 polyunsaturated fatty acids and lower docosahexaenoic acid in men with pedophilia

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Abstract

BACKGROUND: Previous studies have suggested that abnormalities in plasma phospholipid fatty acids may play a role in aggressive behavior. Recently, it was suggested that a dysfunctional serotonergic turnover in the brain may be involved in the etiopathology of pedophilia. Depletion of n-3 polyunsaturated fatty acids (PUFA) may cause alterations in the serotonergic system that may be related to pedophilia and aggression.

METHODS: This study examines the serum phospholipid n-3 and n-6 PUFA fractions in pedophilia. Twenty-seven pedophilic men and eighteen healthy volunteers participated in this study.

RESULTS: In pedophilia there was a significant depletion of the C22:6n-3 (docosahexaenoic acid, DHA), total n-3 fractions and an increase in the total n-6/n-3 and C20:4n-6/C20:5n-3 (arachidonic acid/eicosapentaenoic acid) ratios. Using the NEO Personality Inventory, lower DHA in pedophiles is related to more impulsiveness and lower agreeableness (trust, altruism, straightforwardness, compliance) and conscientiousness (self-discipline).

CONCLUSIONS: The results of this study suggest that a depletion of the serum phospholipid n-3 higher unsaturated fatty acids (HUFAs) and, in particular, of DHA may take part in the pathophysiology of pedophilia. One hypothesis is that a depletion of n-3 HUFAs and DHA may cause alterations in the serotonergic turnover, which are related to impulse discontrol and aggression-hostility, behaviors which are associated with pedophilia.

ORIGINAL ARTICLE

Introduction

Pedophilia is one of the paraphilias, which are diagnosable psychiatric syndromes characterized by recurrent sexual fantasies involving unusual objects or activities, intense associated cravings and stereotypic behavioral responses [1]. The DSM IV [2] describes the paraphilias as an impulse control disorder [3]. Patients with paraphilias experience tension or arousal before committing the sexual act,

experience pleasure during the act and feel a release of tension after the act [3]. Pedophiles use varying degrees of persuasion, coercion or physical force in their sexual assaults, which may cause damage to the physical integrity of the child victim (sexual violence) [4].

Recently, it has been suggested that in pedophilia there is decreased activity of the serotonergic presynaptic neuron and a 5-HT2 postsynaptic receptor hyperresponsivity [5]. Since serotonin exerts an inhibitory effect on aggressive/violent and impulsive behavior, we have suggested that the above changes in the serotonergic system in pedophilia may take part in its pathophysiology [5].

There is considerable evidence suggesting that dietary polyunsaturated fatty acids (PUFAs) influence brain function and play an important role in determining cell membrane fluidity (in conjunction with cholesterol), which in turn, has a strong influence on the expression and function of the serotonin (5-HT) reuptake sites and serotonin receptors [6–10]. Docosahexaenoic acid (DHA, C22:6n-3) is a major structural component of neural membranes in the brain. In rhesus monkey, diets low in omega-3 fatty acids result in lowered DHA levels in cerebral cortex [11]. In rats, an omega-3 fatty acid deficient diet results in a 44 % increase in serotonin 2A receptor density in the frontal cortex [10].

There are some reports that changes in fatty acids may be related to violence and impulse control disorders. Virkunnen et al. [12] reported abnormalities of plasma phospholipid fatty acids in violent offenders. Corrigan et al. [13] found significant increases in oleic acid (C18:1n-9) and decreases in arachidonic acid (C20:4n-6) in plasma phospholipids, cholestereyl esters and high density lipoproteins of offenders. Low cholesterol levels are associated with increased violence [14,15]. Hibbeln suggested that low plasma docosahexaenoic acid (C22:6n-3) concentrations, rather than low plasma cholesterol concentrations, may increase predisposition to hostility [16].

Based on these confirmed data we examined the PUFA composition of phospholipids in patients with pedophilia and hypothesized that pedophilia, or at least some of its components, may be accompanied by lower n-3 HUFA levels and in particular by lowered DHA.

Subjects and methods

Subjects

Forty-five Caucasian subjects from Flemish origin participated in this study. 27 pedophilic males and 18 healthy male volunteers. The former were asked to participate when screened as part of an outpatient sex offender treatment program at the Antwerp Forensic University Center. Patients were told that all data would remain anonymous and would have no effect on any legal decision. Strict DSM-IV [2] criteria for pedophilia were used to make the diagnosis. All patients had displayed repetitive pedophile behaviors for several years and had used sexual aggression (physical force) and sexual violence. Their behavior involved sexual activity (not incestuous) and resulted in injuries to children.

Patients and normal volunteers were screened for present, past and family history of mental disorder by means of the structured interview according to the DSM-IV. Normal volunteers with current or past history of psychiatric disorders and those with family history in first degree relatives were excluded from this study. We excluded patients with other axis-I diagnoses beside paraphilia, such as major depression, anxiety disorders, including obsessive compulsive disorder, psychosis, organic mental disorder, and substance use disorder. All subjects were free of any medical drugs for at least two months prior to blood sampling. No one was a regular drinker or had been taking illegal or major psychotropic drugs, such as antidepressants and antipsychotic agents. All subjects had a physical examination. The following blood tests were performed to exclude subjects with medical illnesses: sedimentation rate, serum electrolytes, thyroid function tests, such as assay of thyroid secreting hormone, renal and liver function tests. Subjects had normal chemical and hematological tests, including blood urea, serum creatinine, SGPT, SGOT, γGT, serum electrolyes, hemoglobin, and hematocrit. Subjects were free of any medical illness, including immune and endocrine disorders, such as diabetes, autoimmune disorders, hypertension, convulsions, disorder in renal and liver function. A radiograph of heart and lungs and ECG were taken. Subjects not consuming the normal Belgian diet (the mean P S ratio of a Belgian diet is 0.54 ± 0.43) were excluded to participate. All subjects gave written informed consent after complete description of the study.

Methods

In patients and healthy volunteers fasting blood samples were taken at 8:00 a.m. Serum was frozen at −30°C until thawed for lipid analysis. Samples of pedophilic men and normal volunteers were analyzed simultaneously. Lipids were extracted [17] and the phospholipids esters isolated by a thin layer chromatography [18]. Their fatty acids were converted into methyl esters [19] whose weight percent composition was determined after separation on a 25 m x 250 μm X 0.2 μm df Silar 10C column (initial temperature 150°C; 1 min isothermal; programmed to 200°C at 1°C/min), installed in a Varian Model 3500 gas chromatograph equipped with a flame ionization detector (275°C) and a glass splitter (250°C). Split ratio was 1/15. Peak identification was done by spiking with authentic standards (Alltech). Peak integration and calculation was performed electronically with a Varian Model 4290 integrator. Results are given as a percentage of the total fatty acids. We determined the PUFA fractions in serum phospholipids, since this fraction determines the PUFA content in cell membranes.

Fatty acids can be classified in three families: saturated (SFAs), monounsaturated (MUFAs) and polyunsaturated (PUFAs) fatty acids. The latter are further divided in the linoleic acid (C18:2 n-6; LA) and α-linolenic acid (C18:3n-3; α-LNA) series. α-LNA and LA, which are found in linseed oil, soy bean oil or corn oil, are substrates from which higher n-3 and n-6 PUFAs are synthesized,

such as C20:4 n-6 (Arachidonic acid, AA), C20:5n-3 (Eicosapentaenoic acid, EPA), C22:5n-6 (Docosapentaenoic acid, DPAn-6) and C22:6n-3 (Docosahexaenoic acid, DHA). The higher unsaturated fatty acids DHA and AA can be ingested directly or biosynthesized from their essential fatty acid precursors C18:3n-3 and C18:2n-6, respectively.

Statistics

Normality of distribution was ascertained with the Kolmogorov-Smirnov test. The independence of classification systems has been checked by means of analysis of contingence (χ2-test). Relationships between variables were assessed by means of analysis of Pearson′s product moment or through multiple regression analysis. Group mean differences were assessed by means of analysis of variance (ANOVA) and linear discriminant analysis (LDA). The statistical analyses in Table 1 were examined after p-correction (at p=0.005, two tailed).

Results

Table 1 shows that there are no significant differences in the n-6 PUFA fractions between pedophilic men and controls. There was a trend (p=0.02) toward lower C20:5 n-3 in pedophiles than in controls. C22:6 n-3 was significantly lower in pedophiles than in normal controls. Figure 1 shows the scatterplot of the DHA values. Total n-3 was significantly lower in pedophile subjects than in normal controls. The total n-6 / n-3, C20:n-6 / C20:5n-3 and C22:4n-6 / C22:6n-3 (which is regarded as an index of DHA deficiency) ratios were significantly higher in pedophiles than in controls. By means of LDA, we found that DHA and total n-3 showed a highly significant (F=17.1, df=1/44, p=0.0003) discrimination between pedophiles and normal controls.

We have also examined the relationships between DHA and personality characteristics as measured by means of the NEO Personality Inventory (NEO-OI-R), 30 NEO facets scale (20). DHA was significantly and positively correlated to the domain agreeableness (r=0.52, p=0.01) and the facets: impulsiveness (r=–0.45, p=0.04), activity (r=0.45, p=0.04), trust (r=0.46, p=0.03), straightforwardness (r=0.58, p=0.006), altruism (r=0.46, p=0.03), compliance (r=0.46, p=0.03) and selfdiscipline (r=0.47, p=0.03). Figure 2 shows the correlations between DHA and impulsivity and straightforwardness. Automatic multiple regression analysis showed that 57.3% of the variance in DHA could be explained by the regression on impulsivity (F=5.6, p=0.029), anxiety (F=8.1, p=0.01) and straightforwardness (F=7.0, p=0.016) (all positively loaded in the regression analysis except impulsivity).

Discussion

This is a first report that DHA (C22:6n-3) and the total n-3 contents of serum phopholipids are significantly lower in pedophile men than in controls. These findings may be important in the understanding of the pathophysiology of pedophilia. Indeed, peripheral PUFA concentrations determine brain PUFA contents, which in turn may determine the expression of receptors, which may be related to pedophiliac behavior.

Table 1. Selected fatty acids (weight %) and combinations in serum phospholipids in normal controls and pedophiles.

Fatty acids	Pedophiles	Controls	F*	df	p
PUFA n-6					
C18:2n-6	22.53 (3.51)	21.40 (2.64)	1,3	1/44	0,2
C20:4n-6 (AA)	8.89 (1.60)	8.92 (1.67)	0	1/44	1
C22:4n-6 (DPAn-6)	0.05 (0.12)	0.13 (0.17)	3,2	1/44	0,08
C225n-6	0.16 (0.10)	0.16 (0.08)	0	1/44	0,9
total n-6	35.23 (2.33)	33.96 (2.13)	3,4	1/44	0,07
PUFA n-3					
C18:3n-3	0.17 (0.08)	0.17 (0.08)	0	1/44	0,8
C20:5n-3 (EPA)	0.74 (0.32)	1.17 (0.72)	6,3	1/44	0,02
C22:6n-3 (DHA)	2.84 (1.77)	3.87 (0.89)	17,1	1/44	0.0003
total n-3	4.74 (1.19)	6.31 (1.45)	15,7	1/44	0.0005
Ratios					
total n-6/total n-6	7.91 (2.11)	5.68 (1.43)	15,4	1/44	0.0006
AA/EPA	15.26 (7.29)	9.43 (4.21)	9,4	1/44	0,004
DPAn-6/DHA	0.33 (0.1)	0.26 (0.06)	6,9	1/44	0,01

All results are shown as mean (±SD) and as a percentage (fraction).
*All results of analyses of variance.
AA: arachidonic acid; DPAn-6: docosapentaenoic acid n-6; EPA: eicosapentaenoic acid; DHA: docosahexaenoic acid

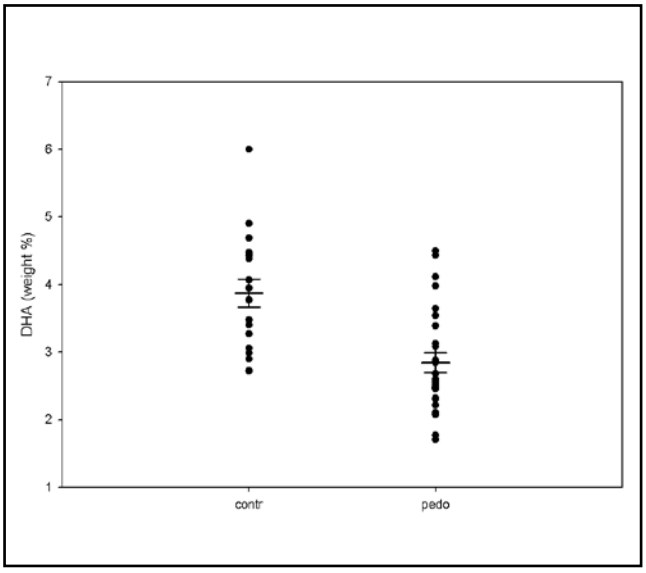

Figure 1. Point and scattergram of the DHA values in pedophiles and controls.

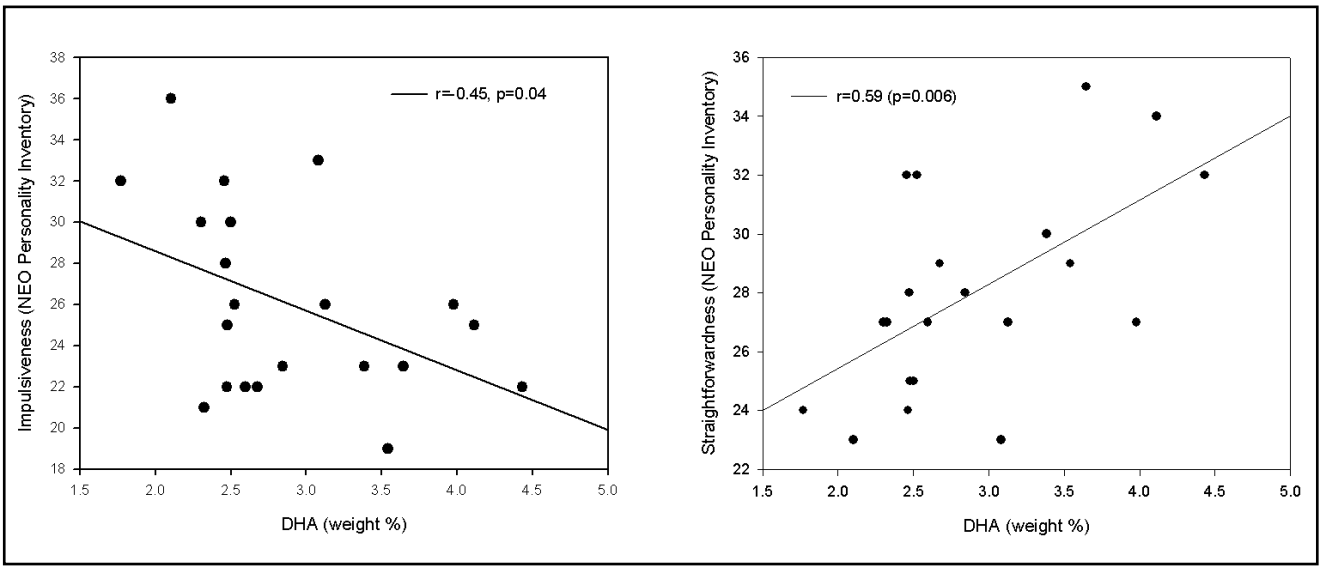

Figure 2. Correlation between DHA and impulsiveness (left) and straightforwardness (right) as measured with the NEO Personality Inventory (NEO-OI-R), 30 NEO facets scale.

Thus, peripheral PUFAs to a great extent determine the membrane composition of PUFAs in the brain [11]. For example, a diet deficient for n-3 PUFAs depletes the cerebral membranes of neurons and astrocytes from n-3 PUFAs including DHA, and induces behavioral changes, such as increased behavioral reactivity to stress in rhesus monkeys [21], alterations in operant and passive avoidance behavior and increased anxiety in the rodent [22]. There is now evidence that in the brain the longer chain PUFAs including DHA are supplied by the blood through the choroid plexus [23,24]. Therefore, the significantly lower n-3 PUFAs including DHA may induce changes in the fluidity of the central neuronal membranes thereby affecting the function of the serotonergic neuron. Indeed, there is now evidence that membrane PUFAs and cholesterol regulate 5-HT release and reuptake, the activity of tryptophan hydroxylase and the brain concentrations of 5-HT and 5-hydroxyindolacetic acid [6–10]. Moreover, n-3 PUFA deficiency induces a significantly increased density of 5-HT2 receptors in the frontal cortex [10]. Thus, the serotonergic dysfunctions which are thought to play a role in the pathophysiology of pedophilia, i.e. a diminished activity of the presynaptic serotonergic neuron and 5-HT2A/C receptor upregulation, could be caused by n-3 PUFA depletion.

Another major finding of the present study is that DHA in pedophiles is significantly correlated to various personality facets. Thus, lower DHA is related to higher impulsiveness and lower levels of agreeableness, activity, trust, straightforwardness, altruism, compliance and selfdiscipline Phrased differently, lower DHA in pedophiles appears to be related to higher levels of neuroticism (impulsiveness) and lower levels of agreeableness (trust, altruism, straightforwardness, compliance) and conscientiousness (self-discipline). Previously it has been reported that low plasma DHA concentrations may increase the predisposition to hostility [16]. As far as pedophilia is related to violence/aggression (see Introduction) our findings are in agreement with previous reports on PUFA levels in violent offenders [12].

In conclusion, this is the first study to report significantly lowered n-3 HUFAs and DHA in the phospholipid fraction of pedophile men. It is hypothesized that low n-3 PUFAs and DHA may be related to the pathophysiology of pedophilia, or at least some of the components of pedophile behavior, through modulation of the serotonergic system. Prospective dietary intervention trials will be required to determine if increasing dietary intake of DHA may be helpful in the treatment of pedophilia or in modulating personality characteristics, such as impulsiveness.

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