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Role of sex hormone-binding globulin in the relationship between sex hormones and antisocial and aggressive personality in inmates

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Abstract

Plasma total testosterone (TT), free bioavailable testosterone (BT), sex hormone-binding globulin (SHGB), luteinizing hormone (LH), and follicle-stimulating hormone (FSH) were analysed in a sample of 89 inmates. Also, the tendency towards an Antisocial Personality Disorder (AAPS) and Aggressiveness (based on an index containing three scales of the Buss–Durkee Hostility Inventory; BDHI) was assessed. Results showed strong correlations between SHBG, total testosterone and free bioavailable testosterone. SHBG and total testosterone correlated with Aggressiveness (0.39 and 0.29, respectively), though the latter turned out not to be significant when SHBG level was controlled. The group with a high probability of Antisocial Personality Disorder and the group with high scores in Aggressiveness obtained higher SHBG levels. Recidivists and subjects already sentenced presented higher concentrations of SHBG. No significant relation was found for the free bioavailable testosterone. It is argued that the relationship between testosterone and antisocial personality and aggressiveness is mediated by the role of SHBG. We conclude that subjects with a disinhibited life-style tend to abuse intoxicants affecting the production of SHBG in the liver. This effect is observed in healthy subjects and delinquents, but more strongly in the population of delinquents.

Keywords: Total testosterone; Free testosterone; SHBG; Antisocial Personality Disorder; Aggressiveness

1. Introduction

Animal studies in the 1940s and 1950s showed that androgens, particularly testosterone, were directly involved in the behaviour of social dominance and aggressiveness (Rose et al., 1971; King, 1975; Dixson and Herbert, 1977). During the 1970s, many investigators attempted to relate testosterone to hostile and aggressive behaviour in human males. Though contradictory, some of the results related testosterone to aggressiveness (see the reviews by Persky, 1985; Archer, 1991). A good deal of this research into sexual hormones and aggressiveness in humans has been carried out through self-reported personality questionnaires.

Persky et al. (1971) were pioneers in establishing relationships between aggressiveness and testosterone in groups of healthy and psychiatric subjects. This study reported a correlation between the Buss–Durkee Hostility Inventory (BDHI) and plasmatic testosterone of 0.49,

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the production rate of testosterone being 0.66. Other researchers tried to replicate the results of Persky et al. (1971) in samples of psychiatric patients, non-delinquents, and delinquents, including sexual criminals. Most of these studies were reviewed by Persky (1985). All of them analysed plasma total testosterone or protein-bound testosterone, but neither free (nor bioavailable) testosterone nor other gonadal hormones such as luteinizing hormone and follicle-stimulating hormone were measured.

Very small fractions of the biologically active steroid hormones in plasma exist in the unbound state. In the case of testosterone, it is also bound partly to albumin and corticosteroid-binding globulins (CBG), and the main fraction (98%) is bound to sex hormone-binding globulin (SHBG). Rada et al. (1976) found higher levels of total testosterone and aggressiveness, measured by the BDHI, in an alcoholic rapist. Since alcoholics have higher levels of SHBG (Vilalta et al., 1997; Iturriaga et al., 1999) and testosterone joins molecule to molecule with SHBG, it is very probable that high concentrations of plasma testosterone in the alcoholic rapist were an effect of SHBG. The abuse of alcohol and other intoxicants is more habitual in delinquents. In consequence, these subjects tend to present chronic hepatic alterations.

Testicular testosterone secretion is principally governed by luteinizing hormone (LH) acting on the rate-limiting step, the conversion of cholesterol to pregnenolone within Leydig cell mitochondria (Handelsman, 1995). Also, follicle-stimulating hormone (FSH) is related to the initiation and maintenance of sperm production through stimulation in the Sertoli Cells. Circulating SHBG is secreted by the liver and persists in blood in nanomolar concentrations. Free or dialyzable testosterone is estimated after the fraction of testosterone in blood that is not bound to protein. These assays require the determination of the percentage of unbound testosterone by a dialysis procedure, estimation of total testosterone, and the calculation of free testosterone. The biological interaction among LH, FSH, testosterone and SHBG requires that these substances be included in studies of sexual hormones and psychological variables (Aluja and Torrubia, 2004).

Few studies of aggressiveness and sexual hormones carried out in criminals have included both SHBG and free testosterone. In addition, the different methods used to calculate the free fraction of testosterone have been criticized. These calculations are often inaccurate, especially when testosterone levels are low and SHBG levels are elevated. When obtained by such assays, values substantially differ from values obtained using a variety of other methods (Rosner, 1997). It has been shown that these direct measurements (by an analog ligand immunoassay procedure) are unlikely to be reliable parameters of free testosterone activity. Bioavailable fractions of testosterone can also be calculated if testosterone, SHBG, and albumin levels are available (Sodergard et al., 1982). The calculation of free and non-specifically bound testosterone fractions was demonstrated to be a simple and a reliable method to measure these hormone concentrations (Vermeulen et al., 1999).

Stålenheim et al. (1998) studied the relationship among levels of total testosterone, free testosterone and SHBG in a sample of 61 men sentenced for violent crimes such as assault, sexual offences, murder, robbery, kidnapping, and arson. All subjects had been detoxified from drugs and alcohol before the investigation. After the exclusion of psychotics, all subjects were diagnosed as having at least one DSM-III-R Axis I/II abuse disorder or personality disorder. Subjects were separated into a disorder or no disorder group. Results showed higher serum levels in total testosterone and SHBG for alcohol disorders, type II alcoholism, cluster B personality disorder, and antisocial personality disorder, but not for the free testosterone. Subjects with scores ≥ 30 on the Hare Psychopathic Check-list Revised (PCL-R) had levels significantly higher than subjects with low scores on the PCL-R. Only subjects with high scores in factor II of the PCL-R had higher levels of total testosterone. Also, violent subjects had high levels of SHBG. No differences were found in free testosterone for the PCL-R and the presence of violent crimes. Räsänen et al. (1999) carried out a similar study in male criminals. They found that subjects with a personality disorder had significantly higher serum levels of total and free testosterone than criminals with schizophrenia. In the same sample, recidivists with personality disorders had higher total and free testosterone levels than non-recidivists with a personality disorder.

Mean differences seem only consistent for SHBG, since differences observed for total testosterone disappeared when controlling for the effect of SHBG. Note that plasma total testosterone correlates highly with SHBG (Stålenheim et al., 1998). The authors also stated: "The differences in serum levels of testosterone and SHBG between groups in this population cannot be explained by hepatic damage per se" (p. 86). However, hepatic alterations provoked by the abuse of alcohol or other drugs remain in spite of being treated (Iturriaga et al., 1999), and the duration of endocrinological recovery is a quite long-lasting process (Ruusa and Sundell, 1997).

Prompted by the findings of Stålenheim et al. (1998) and Räsänen et al. (1999), our aim is to test the