Is semen quality affected by male body fat distribution?

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Introduction

It is well known that deviations from normal body weight disturb the endocrine system, especially the gonadal hormones. In women, both anorexia nervosa and obesity cause anovulation and impair the fertilizing capacity (Koloszar et al., 2002).

In the intercellular septum of fat tissue, cytochrome p450 aromatase converts androstenedione to oestrone and testosterone to oestrogen. In males, oestrogens exert a negative feedback effect on the hypothalamus–pituitary–gonadal system, resulting in decreased levels of gonadotrophins.

The abdominal, android type of fat deposition is a risk factor for cardiovascular diseases, diabetes mellitus, insulin resistance, differences in serum lipid profile and acute pancreatitis (Hollmann et al., 1997; Herold, 2001; Mery et al., 2002). The fat deposition is classified as gynoid when the waist/hip ratio is <0.85, intermediate when it is between 0.85 and 1.0, and android when it is >1.0.

A recent study revealed differences in fat distribution between infertile women and normal controls. The different fat patterns were accompanied by different prognoses of infertility (Kirchengast & Huber, 2004).

The aim of our study was to determine whether the waist/hip ratio is correlated with the semen parameters and the sexual hormone levels (especially the testosterone/17β-oestradiol ratio) in males who do not display other possible cofactors of deteriorated semen parameters.

Materials and methods

Location

Andrology Unit, Department of Obstetrics and Gynecology, University of Szeged, Hungary.
Fat distribution and semen quality

Patients

The study involved male patients of reproductive age, who presented at our clinic because of infertility problems in their marriage. In a 1-year period of study, the variances in the seasons were examined. The exclusion criteria were smoking, regular alcohol consumption, drug abuse, prescription-only medication, any acute disease in the previous 3 weeks, or any chronic disease such as hypertension or diabetes mellitus. Physical examination of the participants revealed no organic alterations of the reproductive organs, such as varicocele, obstruction or absence of the deferent duct, absence of the testes or a testis volume below 12 ml, or any abnormal location of the testes. Cultures were made from each semen sample examined. In the presence of pathogenic aerobic or anaerobic bacteria or fungi in the semen, the patient was excluded from the study. We also excluded those who had azoospermia or severe oligozoospermia because of obstructive azoospermia, Y-chromosome microdeletion, Sertoli cell only syndrome, etc.

Anthropometric measures

The weight and height were measured and expressed in kg and cm respectively (Seca 880 Weight Scale, Leicester Height Measure; Seca Ltd, Vogel & Halke, Hamburg, Germany). The circumference of the waist was measured halfway between the iliac crest and the bottom of the 12th costal bone, at the end of normal expiration, using a Waist watcher measure tape (meterex Karl Kuntze, Langenfeld, Germany). The hip circumference was determined with the same tape at the level of the tuberculi majoris.

Semen analysis

The semen analysis and evaluation process was performed in accordance with the standard criteria of the World Health Organization (1999). Sperm samples were produced by masturbation into a sterile, wide-mouthed, calibrated glass container following a standardized 5-day abstinence period. After 30-min liquefaction, the semen characteristics were quantified by using a Makler semen counting chamber (Sefi-Medical Instruments, Haifa, Israel) under the 200× magnification of an Olympus CH 2 phase contrast light microscope (Olympus Optical Co., Tokyo, Japan). Sperm concentration (10^6 ml⁻¹) and motile sperm ratio (%) were assessed by the same independent qualified assistant. The categories of motility were as follows: rapid progressive motility (grade A), slow progressive motility (grade B), nonprogressive motility (grade C) and immotility (grade D), in accordance with the WHO standards (World Health Organization, 1999). Total sperm count (volume × sperm concentration), total number of motile sperm cells (ejaculate volume × sperm concentration × motility × 10^-1) and rapid progressive motile sperm count (ejaculate volume × sperm concentration × grade A motility × 10^-1) were calculated. The examinations were repeated after a 3-week period under the same conditions, and the better values were accepted.

Reproductive hormones

Peripheral venous blood samples were taken for hormone measurements between 8:00 and 9:00 AM. Levels of spermatogenesis-related hormones were determined by using automated Immulite® chemiluminescent immunoassays (Diagnostic Products, Los Angeles, CA, USA). The normal ranges were as follows: follicle-stimulating hormone (FSH) = 0.7–9.0 IU l⁻¹, luteinizing hormone (LH) = 0.8–7.6 IU l⁻¹, prolactin = 0.11–0.45 IU l⁻¹, 17β-oestradiol = 70–205 pmol l⁻¹, testosterone = 6.9–28 nmol l⁻¹ and sexual hormone-binding globulin (SHBG) = 7.2–33 nmol l⁻¹.

Statistical analysis

Statistical analyses were performed by using SPSS 11.0 for Windows statistical software (SPSS Inc. Chicago, IL, USA). Parametric or nonparametric tests such as the t-test, the Mann–Whitney test and the Pearson or Spearman correlation tests were applied where appropriate. Results are given as correlation coefficients, mean ± SD or median (range). P < 0.05 were considered statistically significant.

Results

Characteristics of the study population

A total of 81 males were involved in the study during the 1-year study period from 1 June 2003 to 31 May 2004. The mean age of the study population was 32.2 ± 5.6 years (range 23.7–52.2). The measured anthropometric characteristics are shown in Table 1. No seasonal changes in this study population were observed in terms of semen quality or hormone levels.

Seminal characteristics

The results revealed a significant correlation between the hip circumference and the sperm concentration (r = −0.24; P = 0.033) (Fig. 1).

Both the waist circumference and the hip circumference were correlated with total sperm count, total number of motile sperm cells and rapid progressive motile
sperm count, but none of these sperm parameters correlated significantly with the waist/hip ratio (Table 2).

The semen volume correlated significantly with the waist circumference and the waist/hip ratio, but not with the hip circumference (Table 2).

The oligozoospermic (<20 × 10^6 ml^-1; n = 15) patients did not differ from the normozoospermic (≥20 × 10^6 ml^-1; n = 66) patients, and the asthenozoospermic (n = 49) patients did not differ from those with sperm of normal motility (>50%) (n = 32) with regard to the anthropometric parameters.

**Hormonal characteristics**

The waist circumference and the hip circumference correlated with the testosterone level, the prolactin level, the SHBG level and the testosterone/17β-oestradiol ratio (Table 3).

The weight of the subjects correlated only with the total sperm count and total motile sperm count from among the sperm parameters, and also correlated significantly with the SHBG level, the testosterone level and the testosterone/17β-oestradiol ratio (Table 3).

The BMI and the waist/hip ratio correlated with the testosterone and SHBG levels and the testosterone/17β-oestradiol ratio, as shown in Table 3.

The SHBG was mostly affected by the body fat content: higher values of weight, BMI, waist and hip circumferences and waist-to-hip ratio were associated with lower SHBG levels (Table 3).

No correlation was found between FSH, LH or 17β-oestradiol levels and any of the anthropometric parameters.

### Android versus intermediate fat deposition

Android (n = 10) and intermediate (n = 71) fat deposition were associated with changes in serum 17β-oestradiol level [median: 73.4 pmol l^-1 (range 73.0–185.0) versus 122 pmol l^-1 (range 73.0–228.0); P = 0.044] and different SHBG levels [median 32.1 nmol l^-1 (range 12.7–87.4) versus 29.25 nmol l^-1 (range 17.7–35.9), P = 0.022].

### Discussion

An ever-growing number of reports is concerned about increasing proportions of overweight women and men in...
the developed countries. In Central Europe, an Austrian study reported that the proportion of moderately overweight men rose from 10.9% to 15.5% between 1985 and 2000, while that of overweight men rose from 1.8% to 4.9% (Rami et al., 2004).

Aromatases and oestrogens play important roles in the function of the reproductive organs (Carreau et al., 2002). In earlier work, we found a correlation between weight and semen concentration (Koloszar et al., 2002). It has been demonstrated that not only the BMI, but also the body fat distribution is a risk factor for several diseases (Hollmann et al., 1997; Mery et al., 2002). Possible relationships between sperm parameters and waist and hip circumferences have not been studied previously.

We found no correlation between the waist/hip ratio and any of the sperm characteristics. This suggests that it is not the type of fat deposition that plays an important role in sperm production, but merely the amount of fat. This could well be related to changes in the testosterone/17β-oestradiol ratio. The increased fat produces more oestrogen from testosterone, which suppresses the hypothalamic and pituitary hormonal secretion and can affect the testis directly (Carreau et al., 2002). Moreover, in obesity the SHBG levels are lower, which reflects on further testosterone deficiency.

There are more precise methods for determination of the fat distribution in men, e.g. with the help of computed tomography or MRI, but these methods are not suitable in the daily routine because of the time and cost requirements. Hence, we chose the simple measurement of waist and hip circumferences, and determination of their ratio.

Testosterone has marked effects on oestrogen production in males. Only 20% of the biologically active oestrogen is produced in the testis. The rest is aromatized from androstenedione produced by the adrenal gland. In males, the 17β-oestradiol level is correlated with the fat mass. The aromatization takes place predominantly in the subcutaneous abdominal fat tissue (Vermeulen et al., 2002). Our results support these previous results. Glucose homeostasis also changes under circumstances of abdominal obesity, and disturbances in the glucose metabolism lead to a deteriorated fertilizing capacity in both females and males (Buijs et al., 2004).

Oestrogen excretion can be decreased by the administration of aromatase inhibitors, which can exert an advantageous effect on the testosterone/17β-oestradiol ratio. Thus, there is a subsequent increase in sperm concentration (Haidl, 2002; Raman & Schlegel, 2002).

In future, more attention should be paid to the weight of patients, especially the mass of abdominal subcutaneous fat, by measuring the waist/hip ratio not only in cases with oligozoospermia or asthenozoospermia, but also in those with normozoospermia, as an abnormal weight gain can result in deteriorated sperm motility characteristics. Further studies are required to examine the possible positive effects of weight loss on the semen characteristics in obese patients.

Table 3 Correlations between anthropometric parameters and testosterone levels, testosterone to 17β-oestradiol ratio, and the prolactin and sexual hormone-binding globulin levels

<table>
<thead>
<tr>
<th></th>
<th>Testosteronea</th>
<th>Testosterone/17β-oestradiolb</th>
<th>Prolactina</th>
<th>SHBGb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>−0.31/&lt;0.001</td>
<td>−0.22/0.046</td>
<td>0.19/0.088</td>
<td>−0.46/&lt;0.001</td>
</tr>
<tr>
<td>BMI (kg m⁻²)</td>
<td>−0.42/&lt;0.001</td>
<td>−0.28/0.012</td>
<td>0.18/0.116</td>
<td>−0.40/&lt;0.001</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>−0.36/0.001</td>
<td>−0.30/0.007</td>
<td>0.28/0.012</td>
<td>−0.46/&lt;0.001</td>
</tr>
<tr>
<td>Hip circumference (cm)</td>
<td>−0.33/0.003</td>
<td>−0.26/0.02</td>
<td>0.29/0.09</td>
<td>−0.50/&lt;0.001</td>
</tr>
<tr>
<td>Waist/hip ratio</td>
<td>−0.28/0.01</td>
<td>−0.26/0.02</td>
<td>0.19/0.093</td>
<td>−0.35/0.001</td>
</tr>
</tbody>
</table>

Values are given as rP.
Values in bold denote significant correlations.
aPearson test; bSpearman test.

References


