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Original Article

Zinc levels in seminal plasma and its relationship with seminal characteristics

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Abstract

Objectives : To examine the relationship between concentration of zinc in seminal plasma and semen quality. *Methods :* Semen samples from one hundred and fourteen male partners of couples who were attending the Obstetrics and Gynecology Department were collected and analyzed for semen quality as per WHO procedure. The seminal plasma concentration of zinc was determined by flame atomic absorption spectroscopy. *Results ;* The mean zinc levels were lower among azoospermic as compared to oligozoospermic and normospermic groups. A positive correlation was observed between zinc levels and sperm count (r=0.12). Zinc also showed a positive correlation with other seminal indices. Significant correlation was also observed between seminal plasma zinc levels and alpha glucosidase activity. *Conclusions :* Zinc levels in seminal plasma and its relationship with other parameters of semen might give useful information regarding male reproductive dysfunction.

Key words: zinc, sperm count, seminal plasma, semen quality

Introduction

Zinc in human semen seems to play an important role in the physiology of spermatozoa. It is secreted by the prostate in small vesicles called protasomes. Zinc (Zn) in seminal plasma stabilizes the cell membrane and nuclear chromatin of spermatozoa. It may also have an antibacterial function[1].

It has been reported that the male partner contributes in 40% of the cases of infertility. Globally, the incidence of fertility is estimated to be about 13-18%[2]. There has been a rapid increase in reports of declining sperm counts and infertility. Such a rapid increase cannot be attributed to genetic factors alone. Environmental exposure to chemicals, physical agents such as heat, lifestyle factors such as smoking and chewing tobacco, nutritional status and air pollution, have also been reported to affect semen quality. Kumar[3] reviewed literature on reproductive dysfunction and attributed the increase in male infertility to the occupational and environmental exposure to pesticides, toxic metals such as lead, mercury, chromium, solvents, radiation and extreme heat.

Male reproductive capacity is most often judged from the number of sperms and their motility. However, secretions from accessory glands also influence overall semen quality. Data on the influence of specific

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nutrients on spermatogenesis is scarce. As a cofactor for several hundred enzymes, zinc is involved in a variety of general cellular functions, including signal transduction, transcription and replication. Zinc levels have been reported to influence sperm count[4], antioxidant status[5], and seminal viscosity[6]. The aim of the present study was to estimate zinc levels in male subjects and to correlate the same with semen parameters and thereby to assess the relationship of seminal zinc levels and male reproductive parameters.

Methods

The study was carried out among 114 randomly chosen males attending the Obstetric and Gynecology Department with their partners. On selection of each study subject, the objectives of the proposed study as well as the benefits of the study to the individual and to society as a whole was explained to him. A written consent to participate in the study was obtained from each subject. The ethics committee of the institute cleared the study.

A brief history was obtained from the patient which included personal characteristics, details of smoking and drinking habit along with its duration and frequency, and occupational details including exposure, if any to metals, pesticides, solvents, vapors, heat etc. as well as the duration of exposure. The subject was asked whether he had any past illness or history of usage of medicines. Detailed reproductive history of the couple including the number of years of marriage, history of abortion, miscarriages, neonatal deaths, usages of contraceptives etc. were elicited. Semen samples were obtained by masturbation in a wide mouthed sterile plastic container. All subjects were required to abstain from alcohol, smoking and any sexual activity in the preceding four days. Sperm motility was assessed as per WHO manual 1992[7]. Motility was divided into four categories: grade 1 - fast progressive; grade II - slow progressive; grade III - non-progressive; grade IV – nonmotile. For the purpose of analysis fast progressive motility $\geq$ 25% was considered normal and below that was considered asthenospermic. Sperm count and sperm morphology were carried out as per WHO manual 1992[7].

Zinc estimation - Seminal plasma was diluted 100 times with triple distilled water. Estimation of zinc in diluted seminal plasma was carried out using flame atomic absorption spectrophotometer. (Perkin Elmer Double beam, USA). Lamp used for Zn : Electrode Less Discharge Lamp was used and 213.9 mm wavelength was used for Zn.

The standards used for above analysis were of E Merck (ICP grade). The sample readings were taken and multiplied with appropriate correction factor. Special care was taken to avoid any contamination with metals during ejaculate, storage, and analysis. All laboratory ware used, including containers, were cleaned by soaking in 10% nitric acid for 24 hours and thoroughly rinsing in deionized water.

Results

Mean zinc levels among different groups with respect to count, motility and viscosity are given in Table 1. Out of 114 subjects, 10 were azoospermic, 20 were oligospermic and 84 had normal count. Zinc level in seminal plasma ranged form 8.95 to 327 mg/L. All subjects were from the urban areas of Ahmedabad and none was reportedly taking zinc supplements. The mean zinc level in the study population was 98.8±60.1 mg/L. Comparison of mean zinc level in serum and seminal plasma among different groups revealed that zinc levels were much higher in seminal plasma than in the serum (Table 2). Mean zinc level in both serum and seminal plasma were lower in azoospermics than in oligozoospermics. Males with normal counts had still higher levels. A similar trend was observed when zinc levels were compared between asthenozoospermic group and those having normal motility. Serum zinc levels were also higher in the subjects having normal sperm morphology as compared to teratozoospermic group. However these changes were not statistically significant. All the subjects came from urban areas and none of them had a past history of illness or any medication of illness.

Table 1. Seminal characteristics of the study population.

Parameter	Category	WHO criteria	Number of subjects
Count	Azoospermic	No sperms	10
	Oligozoospermic	<20million / mL	20
	Normospermic	$\geq$20 million/mL	84
Motility	Asthenozoospermic	Grade I motility <25	57
	Normal	Grade I motility $\geq$25	47
Viscosity	Hyperviscous	Thread >2 cm	66
	Normal	Small discrete drops	48

Correlation between zinc in seminal plasma and sperm count, motility, and morphology is given in Table 3. Positive correlations were observed between the seminal plasma zinc levels and sperm count (r=0.16), motility (r=0.12) and viability (r=0.12). However, these correlations were statistically not significant. Correlation coefficient for zinc and sperm count was near statistical significance. However, seminal plasma zinc levels were significantly correlated with α - glucosidase levels in the seminal plasma (r=0.46, P<0.05). Although the correlations of the seminal plasma zinc with semen parameters are statistically not significant, except for α - glucosidase, it was shown to have positive correlation with all semen indices.

Table 2. Zinc levels among different groups in the study population (Mean±SE).

Parameter	Category	Seminal Plasma Zinc (mg/L)	Serum Zinc (ug/L)
Count	Azoospermic	80.0±74.5	827±70.9
	Oligozoospermic	98.2±49.7	865.8±65.2
	Normal	96.6±63.1	881±42.7
Motility	Asthenozoospermic	95.9±7.6	857.5±7.3
	Normal	95.0±8.0	904±11.4
Morphology	Teratozoospermic	96.1±16.5	816.8±21.0
	Normal	98.5±7.8	854±8.2

Table 3. Correlation between seminal plasma zinc and seminal indices.

Parameters	Correlation Coefficient	95% CI
Sperm morphology	0.03	-0.20 to 0.24
Fast progressive motility (%)	0.12	-0.06 to 0.29
Sperm density	0.16	-0.03 to 0.33
Total count	0.12	-0.06 to 0.29
Motile sperm count	0.12	-0.05 to 0.30
α - glucosidase	0.46	0.20 0.66[a]
Fructose	0.26	-0.04 to 0.51
Sperm viability	0.12	-0.11 to 0.34
Total progressive motility (%)	0.15	-0.03 to 0.31

P is 0.03 [a] P<0.05

Discussion

Trace amount of certain metals are essential for the normal growth, development, reproduction and also various other physiological functions. Zinc plays an important role in male reproduction as it plays a role in sperm production and/or viability, in the prevention of the spermatozoa degradation, and in sperm membrane stabilization. A number of animal studies are available on various zinc compounds. Low (12 mg/kg) or medium (120 mg/kg) dose of zinc appeared to enhance reproductive function whereas lowering of reproductive function would result from high dose (240mg/kg) of zinc [8]. In the present study we found lower levels of zinc in groups with lower count compared to normal. Chia et al[4] compared zinc levels between fertile and infertile groups and found geometric means of the seminal plasma zinc concentrations were significantly lower in the infertile group compared with those of the fertile group. Zinc was also found to have a significant correlation with sperm morphology among oligoasthenozoospermic subjects.

Carreras and Mendoza 1997[9] have reported that zinc was significantly correlated with sperm count. In the present study, we found a weak positive correlation between zinc and sperm count, however, the relationship was not statistically significant. Sperm counts are largely variable and are influenced by various factors such as past illnesses, smoking status, use of medication, and abstinence time. In the present study abstinence time was kept constant and special care was taken to ensure identical conditions during sampling, storage, and analysis. The other factors were also eliminated since none of the subjects were suffering from any urogenital infection and none were using any medication.

Fuse et al[10] reported a positive correlation between zinc levels and sperm motility. However, in the present study, we could not find any significant relationship between zinc and sperm motility although the level of zinc was higher among asthenozoospermics as compared to normal. It has been reported earlier that although zinc is required in seminal plasma for normal spermatozoon functionality, excessively high levels of this ion may be related with defective motility in asthenozoospermia samples. We suspect that zinc might be responsible for antioxidant defense system, therefore lower zinc levels would cause oxidative damage. This would generate free radicals that could lead to defective sperm motility. Zinc levels were lower among subjects having hyperviscous semen. However there was no significant difference between the zinc levels in hyperviscous semen and sample with normal viscosity. It was reported earlier that zinc may play some role in modulation of the three dimensional structure of Sgl and Sgll (dominating proteins of seminal coagulum) rendering them more susceptible to proteolytic breakdown by seminal proteases and in particular by the prostatic specific antigen (PSA). However other workers found no significant difference between zinc in normal viscous semen samples compared to ejaculates with hyperviscosity[11].

Results of the present study indicate that zinc has positive effect on sperm count and morphology. It can be inferred that although the correlations are weak and statistical significance was not achieved from the present study, a definite trend was observed. The fact that zinc plays a positive role in influencing the process of spermatogenesis cannot be ruled out. However, before suggesting zinc supplementation for male patients with subnormal semen quality, we recommended that a larger study be carried out considering confounding factors such as smoking, nutritional status, and exposure to cadmium.

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