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Impact of Seminal Plasma Zinc and Serum Zinc Level on Semen Parameter of Fertile and Infertile Males

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Summary:

Background: Despite Zinc (Zn) deficiency being prevalent in humans, less emphasis has been given on the understanding of its impact on male reproduction. Spermatogenesis has a strict requirement for zinc. The relationship of seminal plasma zinc level and semen parameter until now is controversial .

Objective : The study was done to find out the impact of seminal plasma zinc and serum zinc level on semen parameter of fertile and infertile males.

Subjects and methods: The study was done in Center for Assisted Reproduction, a tertiary Infertility center in Dhaka and in the Biochemistry Department of Bangabandhu Sheik Mujib Medical University (BSMMU), Dhaka. Sixteen fertile males were taken as control and sixty nine infertile males were taken as cases. Semen analysis was done according to WHO criteria (.2004). Serum zinc and seminal plasma zinc levels were measured in the Biochemistry Department of BSMMU by Graphite Furnace Atomic Absorption Spectrophotometer.

Result: Seminal parameters between fertile and infertile men showed significantly high sperm count, sperm motility, rapid linear motility, and morphology in fertile group. In fertile men, serum zinc level was lower than the infertile group, whereas the seminal plasma zinc level was higher in the fertile than the infertile group which was not statistically significant. In fertile men except for serum zinc, all parameters showed positive relationship; and in infertile men, except sperm morphology, all other parameters showed negative relationship. Seminal plasma zinc shows positive correlation with all semen parameters in fertile group and negative correlation in infertile group except for sperm morphology. There is negative correlation of serum zinc and seminal zinc-in both groups. Regarding other parameters, semen zinc shows positive correlation with all parameter except sperm morphology in fertile men and negative correlation with all parameter except sperm count in infertile men.

Conclusion: Seminal zinc levels in fertile men are higher than those in the infertile patients although the serum zinc level is lower. Zinc levels in seminal plasma has a direct relationship with semen parameters. Zinc deficiency may be an important risk factor for low semen parameters and idiopathic male infertility.

Key words: Seminal plasma zinc, Semen parameter, Male infertility.

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Introduction:

Zinc is essential for reproduction in human. World Health Organization (WHO) estimates that one-third of world population is deficient in zinc. The geographical regions most affected are believed to be in descending order of severity, South Asia (in particular, Bangladesh and India), Africa and the Western Pacific[1]. Although there is high prevalence of zinc deficiency in humans, the consequences of zinc deficiency on male reproduction is not well-understood. The Zinc concentration of semen is 87 times than that in the blood and has been reported to protect sperm from bacteria and chromosomes damage[2]. Male fertility is influenced by zinc and plays an important role in normal testicular development, spermatogenesis, and sperm motility[3,4]. The concentration of zinc in human seminal plasma is higher than in other tissues. There are conflicting reports on the role of human seminal plasma zinc on sperm quality. Some authors reported significantly different seminal zinc levels between fertile and subfertile groups, indicating low seminal zinc levels in the subfertile populations,[5,6] while some others have shown that there is no difference between the two groups[7,8]. Low zinc

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levels have a negative effect on serum testosterone concentration and seminal volume[9]. Infertile males have lower levels of seminal plasma zinc, which is associated with reduced levels of zinc in the blood[9]. Zinc in seminal plasma stabilizes the cell membrane and nuclear chromatin of spermatozoa[10, 11]. It may also have an antibacterial function[12] and protect the testes against the degenerative changes[13]. It may play a regulatory role in the process of capacitation and acrosome reaction[14]. Despite the high prevalence of marginal Zn deficiency in humans, less emphasis has been placed on the understanding of its impact on male reproduction. Poor zinc nutrition may be an important risk factor for low quality of sperm and idiopathic male infertility[15]. The study was done to find the impact of seminal plasma zinc and serum zinc levels on semen parameters in fertile and infertile males.

Materials and methods:

The study was done in Center for Assisted Reproduction, a Tertiary infertility center in Dhaka, and in the Biochemistry Department of Bangabandhu Sheikh Mujib Medical University, Dhaka. Sixteen fertile males whose wives were pregnant at the time of the assessment were taken as control and sixty nine infertile males whose wives were facing difficulty in conceiving due to poor semen parameters, were taken as cases. Semen analysis was done according to as per World Health Organization guidelines (2004). Serum zinc and seminal plasma zinc levels were measured in the Biochemistry Department of BSMMU by Graphite Furnace Atomic Absorption Spectrophotometer.

Results:

In Table I semen parameters and zinc levels of the fertile and infertile males showed mean semen volume to be 2.46±1.27 ml and 2.47±1.07 ml respectively which was statistically not significant. Comparison of other seminal parameters between fertile and infertile group showed significantly positive parameters in fertile group. Total sperm count, total sperm motility, rapid linear motility of sperm and sperm morphology were 85.00±32.04 and 47.87±46.45 million/ml (P<0.01); 81.88±7.50 and 52.39±23.68% (P<0.001); 69.06±8.98 and 31.45±20.55% (P<0.001); and 52.50±4.47 and 25.00±11.97% (P<0.001) respectively among the fertile(control) and infertile(case) group. Comparison of serum zinc and semen zinc between control and case showed no significant difference in serum zinc 68.39±14.37 and 75.83±17.41 ìg/dl (P=0.116); and semen plasma zinc 6,175.44±2,569.52 and 5,851.46±2,076.11 ìg/dl (P=0.593) respectively.

Table II shows correlation coefficient (r) of seminal plasma zinc concentration with semen parameters. In fertile group, all parameters showed positive relationship; and in infertile, except sperm morphology, all other parameters showed negative relationship. In fertile group, only semen motility showed statistically significant relationship (r = +0.504, P<0.05); but none in infertile group.

Table III shows correlation coefficient (r) of serum zinc concentration with semen parameters. In control, except semen morphology and semen zinc, all parameters

Table-I

Semen parameters and Zinc levels in fertile and infertile males

Parameters (μg/dl) Mean±SD	Control (n=16) Mean±SD	Case (n=69)	P value
Semen volume (ml)	2.46±1.27	2.47±1.07	0.978^{ns}
Total sperm count (million/ml)	85.00±32.04	47.87±46.45	0.003**
Sperm motility (%)	81.88±7.50	52.39±23.68	0.0001***
Rapid linearity (%)	69.06±8.98	31.45±20.55	0.0001***
Morphology (%)	52.50±4.47	25.00±11.97	0.0001***
Serum zinc (ig/dl)	68.39±14.37	75.83±17.41	0.116^{ns}
Seminal P zinc (μg/dl)6175.44±2569.52	5851.46±2076.11	0.593^{ns}	

Unpaired Student's 't' test, ns = Not significant, ** = Significant (P<0.01), *** = Significant (P<0.001)

Table-II

Correlation coefficient (r) of seminal plasma zinc concentration with semen parameters

fertile (n=16)			infertile (n=69)	
Parameters	r value	P value	r value	P value
Volume (ml)	+0.384	0.142^{ns}	0.164	0.179^{ns}
Total sperm count (million/ml)	+0.080	0.768^{ns}	0.222	0.067^{ns}
Motility (%)	+0.504	0.047*	0.076	0.536^{ns}
Rapid linearity (%)	+0.426	0.100^{ns}	0.048	0.698^{ns}
Morphology (%)	+0.298	0.262^{ns}	+0.156	0.202^{ns}

Pearson correlation coefficient test, ns = Not significant, * = Significant (P<0.05)

Table-III

Correlation coefficient (r) of serum zinc concentration with semen parameters

Control (n=16)			Case (n=69)	
Parameters	r value	P value	r value	P value
Volume (ml)	+0.130	0.631^{ns}	0.086	0.481^{ns}
Total sperm count (million/ml)	+0.079	0.770^{ns}	+0.086	0.481^{ns}
Motility (%)	+0.337	0.201^{ns}	0.002	0.988^{ns}
Rapid linearity (%)	+0.508	0.045*	0.065	0.595^{ns}
Morphology (%)	0.368	0.161^{ns}	0.220	0.069^{ns}
Semen zinc (ìg/dl)	0.019	0.945^{ns}	0.112	0.360^{ns}

Pearson correlation coefficient test, ns = Not significant, * = Significant (P<0.05)

showed positive relationship; and in case, except semen total sperm count, all other parameters showed negative relationship. In control, only semen rapid linearity showed statistically significant relationship (r = +0.508, P<0.05); none of the parameters showed significant relationship in case group.

Discussion:

About 6 decades ago, zinc was recognized as an essential micronutrient for human health by Dr. Ananda Prasad, a nutrition chemist at Wayne State University in Detroit, Michigan [16]. The human body contains approximately 2 g zinc in total. Daily requirement of zinc is 10 mg Zn per day for adult women and 12 mg Zn per day for adult men. World Health Organization estimates that zinc deficiency affects one-third of the world's population (about two billion people) with the prevalence rates ranging from 4 to 73% in various regions[17]. In1990 lower levels of zinc were noticed in infertile patient by Kvist et al [18] which was similar in our study.

Some studies indicated that there is no significant difference between Zinc content in fertile and infertile men[19-22].Although in our study serum zinc and seminal zinc was low between fertile and infertile group also did not show any significant difference, serum zinc 68.39±14.37 and 75.83±17.41 ìg/dl (P=0.116); and semen zinc 6,175.44±2,569.52 and 5,851.46±2,076.11 ìg/dl (P=0.593), but some studies found a significant difference between them[23-26] . In our study,fertile subjects had higher levels of zinc in their seminal plasma than infertile group which was in concurrence with the study of Colagar[15].

Comparison of other seminal parameters between fertile and infertile group showed significantly positive parameters in fertile group with statistically significant

increase in total sperm count, total sperm motility, rapid linear motility of sperm and sperm morphology among the fertile(control) and infertile(case) group. Similar findings have reported in previous studies by different authors. High concentration of zinc to be associated with enhanced sperm parameters, including sperm count, motility[23-25,27] , and normal morphology[25, 28], Zhao et al[26] observed a positive relationship between poor production of sperm and poor sperm motility with a lower content of Zn in the seminal plasma of infertile subjects which is in concurrence with our study. In a study done in 1983 Stanwell found a significant positive relationship between sperm density and seminal plasma zinc concentration in the fertile, but not in the infertile men[29]. Wong *et al.*[19] reported increased proportion of spermatozoa with progressive motility after oral zinc supplementation. Steven *et al.*[30] *in his study* observed a negative correlation between seminal zinc content and sperm head defect. In the present study it was observed that there is positive but not significant correlations between zinc content of seminal plasma and motility, total count and sperm concentration. In contrast to our study Wong *et al.*[4], demonstrated that zinc content in fertile men were not different from those of infertile men. Abou-Shakra *et al.*[31], reported that zinc content in men grouped by sperm concentration was not different from each other.

Conclusion:

Zinc may contribute to fertility through its significant effects on various semen parameters. It seems that the estimation of seminal plasma zinc may help in investigation and treatment of infertile males. Seminal zinc may contribute to fertility through its effect on various semen parameters. Seminal zinc level in fertile men is higher than the infertile patients although the serum zinc level is lower. Zinc levels in seminal plasma has a direct relationship with semen parameters. Zinc deficiency may be an important risk factor for low quality of sperm and idiopathic male infertility.

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