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REVIEW ARTICLES

ENVIRONMENTAL AND NUTRITIONAL ASPECT IN MALE INFERTILITY

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Abstract:

Male and female partner of a couple must be standard and fit to have the capacity to procreate. Studies confirm that male sperm counts are declining and environmental factors as pesticides, exogenous estrogen, heavy metals negatively impact spermatogenesis without any obvious anatomical defects. So, a number of nutritional therapies have been shown to improve sperm count and motility as carnitine, arginine, zinc, selenium and vitamin B_{12}. Numerous anitioxidants have prove beneficial in treating male infertility as Vitamin C, Vitamin E, Glutathione and Co-enzyme Q10. This article aims to highlight the correction of nutritional imbalances to encourage optimum sperm production and function, when there is idiopathic impaired spermatogenesis.

Introduction:

An estimated six percent of adult males are found infertile.[1]

Infertility is defined as the inability to achieve a pregnancy after one year of unprotected coitus[2]. Conception is normally achieved within 12 months in 80-85% of healthy couples by regular practice (2-3 times a week)[3]. So there is 15-20% probability of married couple seeking help for their involuntary infertility[4]. Among these, statistically 30% are due to male problems, 30% are due to female problems, 30% due to problems with both partners and 10% are unexplained[3,4]. Certain cases of male infertility are due to anatomical and chromosomal abnormalities (Y chromosome microdeletions) but estimated 40-90% are due to deficient sperm production of unidentifiable origin or a combination of various factors[1,3].These could be due to so many reasons as endocrine abnormality :hyper or hypothyroidism, hyper or hypogonadisum (testosterone deficiency), hyperprolactinaemia, prescription drugs as phenytion, glucocorticoids, cytotoxic drugs, nitrofurantion, sulfasalazine, tetracycline and exposure to occupational and environmental toxins, recreational drugs and alcohol, excessive heat or radiation. Concurrent pathologies as hepatic cirrhosis, hemochromatosis (80% cases), mumps orchiitis(25-30%), influenza, bronchiectasis, previous or recent genito-urinary infections such as tuberculosis and syphilis. Chronic asymptomatic chlamydial infection is found in 28-71% of infertile men.[1,5]

Causes of declining sperm count: There is a growing body of scientific evidence that sperm parameters have declined considerably over the last 50 years, i.e., mean sperm density from 113 million/ml in 1950 to 56 million/ml in 2000 ($p<0.0001$), volume decreased from an average of 3.40 ml to 2.7 ml ($p=.027$).[6,7] This figure clearly showed a 20% drop in volume and 58% decline in sperm production over last 50 years. Three other recent reports also found semen quality has declined among donors over the last 20 years.[8-10] These decline in sperm density is relatively recent, so we must suspect a combination of environmental, life style changes and nutritional or dietary factors may be interfering with spermatogenesis.[11,12]

Environmental Factors:

The probable factor responsible for deteriorating sperm quality are **i)** Environmental risk factors as occupational exposure to various chemicals, heat (sperm production greatly reduces at temp>96^0F) ,radiation, heavy metals e.g. lead, mercury, exposure to environmental estrogens, pesticides[5,11,12], ii) life style risk factors as cigarette smoking, alcohol consumption, chronic stress.[13,14] iii) Nutritional deficiency as Vitamins E,C,B_{12}, zinc, selenium and excessive intake of cottonseed oil which contain toxic pesticide residue and chemical gossypol which is toxic to sperm.[14,15]

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Semen analysis:

Conventionally a normal semen sample should have a volume of 1.5-5ml, with greater than 20 million sperm/ml.[2] It liquefies after half an hour and number of abnormal sperm is <40% with >40% have progressive forward motility. This conventional semen analysis often fails to identify infertile males with normal samples and conversely fails to identify fertile males with abnormal semen parameter. So more sensitive tests are post coital test and hamster egg penetration test which measures the ability of sperm to penetrate cervical mucus or hamster egg. These tests are sensitive (66%) than usual semen analysis(30%).[1,4]

Nutritional therapies for spermatogenesis:

Infertility affects one in 25 men.

The anatomical (retrograde flow) or genetic factor (Y chromosome microdeletion) , congenital causes (Klinefelters syndrome, cystic fibrosis, anorchism & cryptorchism) or congenital hormonal disorders such as leutinizing hormone- releasing hormone (LHRH) deficiency and gonadotropin- releasing hormone(GnRH) deficiency (e.g, Kallman syndrome) cause testosterone deficiency and thus impair spermatogenesis.Varicocele usually does not interfere and so operation for varicocele is not mandatory for efficient sperm production.

Various experiments and research trial have shown the role of different types and quantities of nutrients which directly or indirectly play a dominant role in total sperm count or concentration, morphology and progressive linear motility. They are

1. **Arginine:** This essential Amino Acid is a biochemical precursor in the synthesis of putrescine, spermidine and spermine, which are essential for sperm motility. Schachter et al showed that among 178 men with low sperm count and motility, 128 had a significant improvement in sperm count and motility after taking 4 gm/ day of Arginine for 3 months.[16]

2. Carnitine: The main function of carnitine is to provide energetic substrate for spermatogonia as it is necessary for transport of fatty acids to mitochondria. It thus helps directly to sperm motility and maturation.[17] A multicentre trial among 124 infertile men receiving 3 gm/ day of L carnitine for 4 months, where sperm parameters were assessed before, during and after the study. It showed motility increased from 26.9±1.1 to 37.7±1.1 percent, rapid linear progressive movement from 10.8 to 28 percent and total sperm per ejaculate also increased[18]. Among 4 months trial on 20 infertile men, 12 showed significant improvement, 5 pregnancies occurred during treatment, 2 more occurred during 4 months following trial in another study.

3. Zinc: It is a trace mineral, essential for normal functioning of male reproductive system. More than 200 enzymes in the body involved in various biochemical mechanisms are zinc dependant.[19] Its deficiency is associated with decreased testosterone level and sperm counts.[20] Among 37 patients with idiopathic male infertility, 24 mg of elemental zinc was supplemented in a trial for 45-50 days. It showed a dramatic response in raise testosterone level and sperm count from 8 to 20 million /ml, along with resulting 9 pregnancies.[21]

4. Vitamin B_{12}: Vitamin B_{12} in its various forms are important in cellular replication, especially for synthesis of RNA and DNA. Its deficiency state is associated with decreased sperm count and motility. Methylcobalamin was given at a dose of 1500 mg and 6000 mg/day over a group of infertile men for 8-60 weeks. Periodical semen analysis showed a standard sperm parameters increased by 60%. Sperm count increased in 38.4% in 1,500 mg/day group in comparison to 57% improved in 6000mg/day group[22].

Antioxidants:

Polyunsaturated fatty acids and phospholipid of cell membrane are key constituents of sperm cell membrane. It is highly susceptible to oxidative damage.Sperm produce controlled concentration of reactive oxygen species as superoxide anion, hydrogen per-oxide and nitric oxide, which are needed for fertilization. But high concentration of these free radicals can directly damage sperm cells[22]. Disruption of this delicate balance is associated with idiopathic male infertility.

1. Vitamin C : Studies have shown that low level of vitamin C lead to infertility and increased damage to sperm's genetic material. Fraga et al showed the effect of vitamin C on male infertility when 30 infertile but otherwise healthy men were given a placebo, 200mg and 1000 mg of Vitamin C daily. After one week, the group receiving 1000 mg/day had a 140% and 200 mg/day group had 112% increase in sperm count and there was no change in placebo group. Most important is that by the end of 60 days study, every participant

in Vitamin C group had impregnated their partner and no pregnancy in placebo group.[23]

2. Vitamin E: It is a well documented antioxidant and have been shown to inhibit free radical induced damage to sensitive cell membrane.[24] Lipid peroxidation in seminal plasma and spermatozoa was estimated by Malondialdehyde (MDA) concentration. Oral supplementation with Vitamin E significantly decreased MDA concentration and improved sperm motility and count, resulting in a 21% pregnancy occurrence during the study.[25,26]

3. Glutathione and Selenium: Glutathione is vital to sperm antioxidative defences. Both Glutathione and selenium are essential to formation of phospholipids hydroperoxide glutathione peroxidase, an enzyme present in spermatid. This is a structural protein of mitochondria in mid place of mature spermatozoa. Deficiency of both lead to instability of mid piece resulting defective motility.[27] Glutathione and selenium was used in two months, placebo controlled, double blind, cross over trial over 20 infertile men. It showed a statistically significant effect on sperms forward motility rather than placebo group.[28]

4. Coenzyme Q-10: In sperm cells coenzyme Q-10 (coQ10) is concentrated in mitochondrial mid piece for energy production. It also functions as an antioxidant, preventing lipid peroxidation of sperm membrane. Co Q 10 (60mg) was given to 17 infertile patients for a mean 103 days showed a significant increase in sperm count and motility with resulting improvement in fertilization rate ($p<0.05$) .[29,30,31]

Conclusion:

Male infertility is a multifactorial disease process with a number of potential contributing factors. Considering the majority of male infertility cases are due to deficient sperm production of unknown origin, environmental and nutritional factors must be evaluated. Occupational risk factors, including exposures to heat, chemicals, heavy metals need to be examined. Avoidance of tight and warm undergarments, taking cold scrotal bath is to be encouraged. Life style and dietary choice as avoidance of alcohol and heavy smoking, reduction of weight in obese, improvement of general health in malnourished, avoidance of exposures to pesticide residue and xeno-estrogen, all may help to improve sperm count and motility.

People are exposed to environmental(synthetic chemicals & hormones) and food adulteration, at the same time there is diminishing sperm quality. So, we can consider the decreased fertility in men is a physiological early warning sign, "A canary in the coal mine," which is acting as a sensitive indicator of environmental disruptions and nutritional imbalances.So, spermatogenesis which is an energetically demanding process requires an optimum intake of antioxidants, minerals and a well balanced nutrients. Combination of these have a beneficial impact on sperm count, motility and ultimately overall fertility.

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