Review Article

VITAMIN D AND MALE FERTILITY

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Abstract: Experimental and observational research found that males with vitamin D deficiency were likely to have testosterone deficiency or be at increased risk for it. Semen quality was also shown to be affected by low vitamin D levels, and it was the most consistent finding. It has been demonstrated that vitamin D directly affects spermatozoa and has a beneficial relationship with sperm motility. By describing experimental and clinical investigations in animals and humans addressing the link between testis function and vitamin D, the current review summarizes current information on the role of vitamin D in male fertility.

Keywords: Vitamin D, Semen quality, Spermatozoa, Male fertility

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INTRODUCTION

Vitamin D is crucial for maintaining bone metabolism and calcium homeostasis. Rickets in children and osteomalacia in adults can result from deficiency of vitamin D. Rickets was successfully eradicated from the world in the 1930s because of fortification of milk with vitamin D. However, up to 1 billion people worldwide still suffer from subclinical vitamin D deficiency, which is still very common in both industrialized and developing nations.[1]

A fat-soluble steroid, vitamin D, its source is either endogenous skin production or food (mainly oily fish, mushrooms and pharmaceutical supplements). When exposed to UV light, 7-dehydrocholesterol in the skin changes into pre-vitamin D. A heat-dependent process rapidly transforms pre-vitamin D into vitamin D (cholecalciferol). Passive diffusion causes dietary vitamin D and other lipids to be absorbed in the intestine.[2]

Vitamin D has received attention recently due to its pleiotropic effects, including endocrine, autocrine, paracrine, and activity on many target organs and systems.

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Its primary function is to control the homeostasis of calcium and phosphate, which aids in the mineralization of the bone. The parathyroid glands, skeletal system, kidneys, and gut are the main target organs of vitamin D. Thus, each of these organs is affected biologically by vitamin D in various ways. A healthy calcium-phosphorus balance is maintained by the intricate regulation of vitamin D metabolism. In actuality, vitamin D promotes calcium and phosphate absorption from the intestine, calcium retention, and phosphate excretion by the kidney, and changes the balance between bone production and resorption strictly on the level of circulating calcium. Vascular endothelium, pancreatic B cells, smooth muscle cells, monocytes and neurons have vitamin D receptors (VDR).[3]

According to the WHO, 60 to 80 million couples have infertility worldwide. Male factors cause nearly 50% of cases of infertility. Studies have revealed that mature spermatozoa, the prostate, and the testis have vitamin D receptors (sperm nucleus and neck). Infertile males who have oligo asthenozoospermia show a considerable increase in the mean sperm count and sperm motility following administration of vitamin D for 6 months.[4] Because the presence of VDR and the vitamin D metabolising

enzyme was shown in the spermatozoa and testis, it has been postulated that vitamin D shows a significant function in the male reproductive organs.[5] Semen and hormone production negatively impact hypovitaminosis D in humans and animals.[6]
Additionally, research on men having hypogonadism had mixed findings. According to several of them, men suffering from hypogonadism had relatively low levels of 25-hydroxyvitamin D3 in their blood than normal men.[7] Still, some studies could not find any association between hypovitaminosis D and hypogonadism.[8]
Interestingly, one study suggested a connection between increased vitamin D levels and hypogonadism.[9]
The interventional investigations did not even reach a consensus on this topic. The outcomes seem to be highly dependent on the duration of vitamin D administration. Short-term (3 months) and very short-term (4 days) supplementations could not affect the total testosterone levels in the blood.[10]
Otherwise, long-term, which includes 12 months of administration of vitamin D2 and D3 in males of different groups and different ages, can significantly increase total testosterone.[11]
Circulating 25-hydroxyvitamin D3 levels positively correlate with sperm count, progressive motility, total sperm motility, and normal morphology.[12] An observational study concluded that ionised calcium and vitamin D can affect testosterone bioavailability and quality of semen in infertile males because all those males with deficient vitamin D had significantly reduced progressive motility of sperm and the total number of motile sperm.[13] Studies have proposed that vitamin D plays a significant role in acrosome reaction. Hyperactivated motility and capacitation are a few Ca^{+2}-dependent activities. It also has been demonstrated that vitamin D affects sperm motility and survival. By controlling crucial processes, including cholesterol efflux and activating threonine and tyrosine residues on certain proteins, vitamin D governs sperm motility and survival. Serial vitamin D levels were favorably connected with normal morphology in normozoospermic males and with sperm motility in all patients.[14] Most research on the effects of vitamin D insufficiency has been done using mice models of the condition. In these mice models of vitamin D insufficiency, defective semen parameters have been demonstrated to be caused by vitamin D deficiency, including lower sperm count, motility, and a larger percentage of defective morphology.[15] Poor semen parameters and vitamin D insufficiency have very rarely been linked in human research.[16]
Semen samples were collected from 40 men from the general population to analyze in vitro response of sperm motility, intracellular calcium and mature spermatozoa's acrosomal reaction. Forty-five minutes of exposure to 1,25(OH)2D3 were given to the semen samples. Through the VDR-mediated release of calcium from those of intracellular calcium storage in this situation, 1,25(OH)2D3 raised intracellular calcium concentration in human spermatozoa, enhanced sperm motility and caused the acrosome reaction.[14] A condition that is sometimes disregarded, vitamin D insufficiency now affects over one billion individuals globally. Like many other nations, Pakistan has a vitamin D insufficiency problem affecting 53.5% of the population.[17]

CONCLUSION

Vitamin D deficiency might lead to subfertility in men by decreasing testosterone levels, sperm count, and sperm motility.

AUTHOR'S CONTRIBUTION

MT: Literature survey
HJQ: Proof reading

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