The Association of Serum Vitamin D and Serum Zinc on Semen Quality among Men's Fertility

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ABSTRACT

Background: Vitamin D and zinc deficiency have been the most common nutritional deficiency worldwide. There is conflicting evidence about the potential link between serum vitamin D levels and serum zinc and semen quality. The aim of this study is to examine how serum zinc and serum vitamin D affect the fertility of males by evaluating the quality of their semen.

Materials and Methods: The cross-sectional study was carried out for 18 months from May 2021 to December 2022 on 103 men who were referred to an infertility clinic center at Kalar, As-Sulaymaniyyah city for their wife's fertility problems. They divided into two different groups of normal sperm parameters and abnormal sperm parameters (55 normal) and (48 abnormal).

Results: The mean values of the semen volume, total sperm concentration, total sperm motility percentage, and normal morphology percentage as well as serum vitamin D and serum zinc were significantly higher in the group with “normal sperm parameter” (55) as compared to subjects (48) “abnormal sperm parameters” group. The serum vitamin D and serum zinc levels were significantly high in men with “normal sperm parameters”; 35.21±10.18 (ng/dL), and, 76.46±12.02 (ng/dL), respectively. Compared with "abnormal sperm parameters" 17.64±10.01 (ng/dL) and 54.14±15.64 (ng/dL) (mean ± SD) with p-value < 0.0001.

Conclusion: A significant decrease in serum vitamin D and serum zinc concentrations has a negative association on semen quality, leading to decrease sperm parameters as well as fertilization rate.

Keywords: Vitamin D, Zinc, Fertility, Semen quality, sperm parameters

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ارتباط فيتامين د ومصل الزنك بجودة السائل المنوي بين خصوبة الرجال العراقيين

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الخلاصة

الخلفية: يعتبر نقص فيتامين (د) والزنك من أكثر أنواع نقص التغذية شيوعًا في جميع أنحاء العالم. هناك أدلة متضاربة حول الصلة المحتملة بين مستويات فيتامين (د) في مصل الدم والزنك في الدم ونوعية السائل المنوي. الغرض من هذه الدراسة هو فحص كيفية تأثير الزنك ومصل فيتامين د على خصوبة الذكور من خلال تقييم جودة السائل المنوي لديهم.

الطريقة: أجريت الدراسة المقطعية لمدة ١٨ شهرًا من ايار ٢٠٢١ إلى كانون الأول ٢٠٢٢ على ١٠٣ رجلاً تم تحويلهم إلى مركز عيادة العقم في مدينة كلار-السليمانية بسبب مشاكل خصوبة زوجاتهم. تم تقسيمهم إلى مجموعتين مختلفتين من البارامترات الطبيعية للحيوانات المنوية بارامترات الحيوانات المنوية غير الطبيعية (٥٥ طبيعي) و (٤٨ غير طبيعي).

النتائج: كانت القيم المتوسطة لحجم السائل المنوي ، والتركيز الكلي للحيوانات المنوية ، ونسبة الحركة الكلية للحيوانات المنوية ، والنسبة المئوية للتشكل الطبيعي بالإضافة إلى فيتامين د والزنك في الدم أعلى بشكل ملحوظ في المجموعة ذات "معامل الحيوانات المنوية الطبيعي" (٥٥) مقارنة بالمواضيع. (٤٨) مجموعة "معاملات الحيوانات المنوية غير الطبيعية". كانت مستويات فيتامين د والزنك مرتفعة بشكل ملحوظ لدى الرجال الذين لديهم "معايير طبيعية للحيوانات المنوية". ٣٥.٢١ ± ١٠.١٨ (نانوغرام / ديسيلتر) و ٧٦.٤٦ ± ١٢.٠٢ (نانوغرام / ديسيلتر) على التوالي. مقارنة بـ "معلمات الحيوانات المنوية غير الطبيعية" ١٧.٦٤ ± ١٠.٠١ (نانوغرام / ديسيلتر) و ٥٤.١٤ ± ١٥.٦٤ (نانوغرام / ديسيلتر) (متوسط ± SD) بقيمة p <0.0001.

الخلاصة: إن الانخفاض المعنوي في تركيز فيتامين (د) والزنك في الدم له علاقة سلبية بجودة السائل المنوي ، مما يؤدي إلى انخفاض قيم الحيوانات المنوية وكذلك معدل الإخصاب.

الكلمات المفتاحية : فيتامين د ، زنك ، خصوبة ، جودة السائل المنوي ، بارامترات الحيوانات المنوية

INTRODUCTION

Infertility is defined as the "inability to conceive a child or carry a pregnancy to term after one year of regular, unprotected sexual intercourse". It can affect both men and women and may have a variety of causes [1].

According to the "World Health Organization", infertility affects around 48.5 million couples worldwide. Women account for approximately as many cases of infertility as men, who account for 40% of cases. For the remaining 20%, either both parent contributed or the cause is unknown [2,3].

Possible causes of infertility in men may include low sperm count or poor sperm quality, abnormalities in the sperm's shape or structure (morphology), ejaculation problems, hormonal imbalances, genetic disorders, and health conditions such as diabetes or celiac disease [4,5].

Environmental factors, such as exposure to certain chemicals or radiation, may also contribute to male infertility [6,7].

Semen analysis is a clinical method used to assess male fertility potential. Various macro- and micronutrients, including "fructose, amino acids, potassium, galactose, magnesium, zinc and vitamin C" are found in semen. A female ovule's capacity to be fertilized by the semen depends mainly on the quality and quantity of sperm present[8].

While semen quality is often influenced by demographic factors like age and lifestyle factors like "Body Mass Index (BMI), smoking, and alcohol consumption", certain nutrients have also been shown to affect sperm quality [9-12].

These nutrients include selenium, carnitine, omega-3 fatty acids, [13-15] and various antioxidants have been shown to be related to semen quality [16].

Other potential factor that may influence semen quality is vitamin D and zinc. Vitamin D, a hormone, plays a role in various biological functions such as maintaining bone health, boosting immune system, and supporting male reproductive health [17].

Research has linked a lack of vitamin D to decreased sperm count and mobility, as well as a heightened probability of testicular shrinkage and infertility [18].

Taking vitamin D supplements has been discovered to enhance semen quality and raise the prospects of pregnancy [19,20].

Just like vitamin D, zinc is a vital trace element that participates in a number of crucial bodily processes, such as sperm maturation and movement [21]. Zinc deficiency has been linked to decreased testosterone, disrupted sperm production and quality, weakened sperm function, and reduced fertility [22].

Supplementation with zinc has been demonstrated to elevate testosterone levels and improve sperm quality in individuals with low serum zinc levels [23].

The aim of this study is to examine how serum zinc and serum vitamin D affect the fertility of males by evaluating the quality of their semen.

Methodology:

Study Design

This cross-sectional study was carried out from May 2021 to December 2022, with 103 men who sought treatment at an infertility clinic center due to their partner's fertility issues. They divided into two different groups of normal sperm parameters and abnormal sperm parameters (55 normal 39.89 ± 6.98 years and 48 abnormal 46.10 ±6.50 year). According to "World Health Organization" men considered as a normal sperm parameters when he had a total sperm motility more than 40 percentage, morphology more than 4 percentage and total sperm concentration more than 15 million/mL. [24]. The concentration, motility, and morphology of fresh human semen samples from fertility clinic patients were studied using both manual methods and the SQA Vision® technology[25]. During their appointment, patients were told orally that they need to abstain from sexual activity for three days before providing the sample.

After a period of refraining from sexual activity for 3 to 5 days, the semen samples were collected through masturbation at the andrology unit, with the entire semen output being captured in sterile containers. Patients recorded the length of their sexual abstinence on a written form and confirmed that their entire semen was collected. To achieve total liquefaction, samples were incubated at room temperature for 30-60 minutes. The semen volume was determined by transferring it into a sterile, calibrated tube, and the viscosity was measured using a pipette tip.

Biochemical Analysis:

In this study, the biochemical tests included serum vitamin D analysis carried out using the Cobase 411 analyzer and serum zinc tests performed on the fully automated Cobase C111 analyzer "Roche Diagnostics", which utilizes "ElectroChemiLuminescence" technology for immunoassay analysis.

Sperm Analysis:

Semen samples were obtained through masturbation after a 3-5 day period of sexual abstention and stored in sterile containers. They were then evaluated following the "World Health Organization's" 2010 guidelines. [24].

Statistics:

The statistical differences between the two groups for all parameters were analyzed using the unpaired t-test in Graph Pad Prism 9.3. All variables were expressed as mean ± SD. The level of significance was determined as follows: P-value ≥ 0.1234 was considered not significant, while P-value < 0.0322 (*), < 0.0021 (**), < 0.0002 (***), <0.0001 or P-value ≤ 0.05 were considered statistically significant.

Ethic Approval

The "Kalar Technical College of the Sulaimani Polytechnic University Committee" Ethics Licensing Committee approved a procedure that follows the guidelines set in the Declaration of Helsinki (No. 09) on January 5th, 2023.

RESULTS

In this study, 103 patients (55 normal and 48 aberrant) were enrolled. The average age for the normal and abnormal groups was similar (39.89 ± 6.98 and 40.33 ±3.25 years, respectively). The results revealed that vitamin D levels in the abnormal sperm parameters group (17.64 ± 10.01) were significantly lower (p<0.0001) than those in the normal sperm parameters group (35.21 ± 10.18) as in figure 1. Likewise, as shown in figure 2, there was a significant decrease (p<0.0001) in zinc levels between the abnormal sperm parameters group (54.14± 15.64) and the normal group (76.46 ± 12.02).Table 1 lists the patients' seminal sample's clinical and laboratory parameters. Results revealed that as compared to the abnormal sperm parameters group, patients in the normal sperm parameters group had considerably higher "semen volume, total sperm concentration, sperm motility percentage, and normal morphology".

DISCUSSION

The balance of calcium and phosphate as well as bone health have historically been associated with vitamin D [26]. However, recent research has investigated its involvement in infertility and negative effects on semen parameters [27-30]. The results of these studies have been mixed; some research shows a strong connection between semen parameters and serum vitamin D levels. [28,31], while others have disagreed with this association [32,33].

The current study revealed a significant connection between lower vitamin D and impaired semen parameters, such as "semen volume, total sperm concentration, total sperm motility percentage, and sperm morphology percentage". This result was also agreed with other studies. [34,35]. Zinc is a crucial micronutrient in the human reproductive system as it plays a role in sperm formation and helps maintain the stability of chromosomes. It also affects mitochondrial processes such as cell respiration and apoptosis [36]. The current study revealed that the concentration of zinc had significant decrease (p<0001) in abnormal group compared to normal group. This result agreed with previous research demonstrating that healthy men had much higher zinc concentrations than infertile men [37], but they disagree with findings from other studies that claim that infertile men have higher zinc concentrations than fertile men [38].

Additionally, a study conducted in Estonia revealed that supplementing with zinc could significantly improve the semen volume, motility, and normal morphology of sperm in infertile males. Furthermore, infertile men's sperm quality significantly improved following zinc supplementation [39].

In study, "the association of serum vitamin D and serum zinc on semen quality among men's fertility" of abnormal and normal spermatozoa was investigated. The results showed that poorer semen parameters, such as "semen volume, total sperm concentration, sperm motility, and sperm morphology", were strongly associated with decreased serum vitamin D and serum zinc concentration..

CONCLUSION

This study showed that a significant decrease in serum vitamin D level and serum zinc concentration has an impact on semen quality, leading to decrease semen volume, total sperm concentration, and motility, and increase abnormal sperm morphology and semen viscosity as a result decreased fertilization rate.

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Competing Interests

None.

Table 1 Clinical and laboratory parameters of the patients' seminal samples.

Parameters	Normal case (n=55) "mean±SD" .	Abnormal case (n=48) "mean±SD"	P-value
Age	39.89 ± 6.98	40.33 ±3.25	0.615
Semen volume (mL)	3.75±0.55	1.88±0.98	<0.0001
Total Sperm concentration * 10^6 /mL	51.64±18.63	15.40±3.41	<0.0001
Total sperm motility%	62.85±5.76	46.83±7.83	<0.0001
Normal morphology %	6.17±1.09	3.77±1.13	<0.0001
Viscosity	1.22±0.46	1.83±0.72	<0.0001
Vitamin D ng/dL	35.21±10.18	17.64±10.01	<0.0001
Zinc ng/dL	76.46±12.02	54.14±15.64	<0.0001

"All data are presented as mean ± SD (standard deviation)."

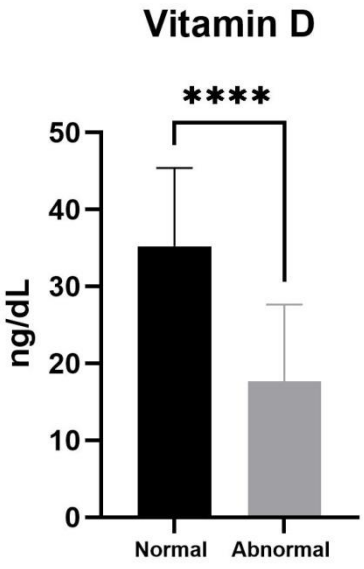

Fig.1: Serum vitamin D concentration (ng/dL) in normal and abnormal group.

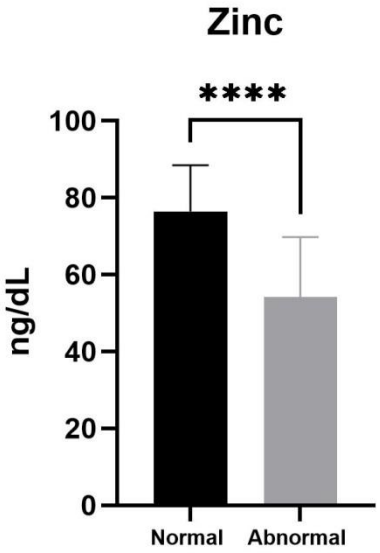

Fig.2 : Serum Zinc concentration (µg/dL) in normal and abnormal group.

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