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Estimation of the effective role of vitamin D in infection patients with burn

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***Abstract*---**The current study aims to investigate the role of Vitamin.D (V.D) in burn patients with a bacterial infection in some Baghdad hospitals, whether the bacterial infection results in sepsis or infection of burn wounds only without sepsis, and knowing the level of V.D in deceased burn patients and burn patients. Recovered and healthy people (standard samples), and compare the two groups (deceased and recovered) with the standard samples. The relationship between the levels of V.D in the study groups and the length of stay in the hospital was also highlighted. The study, which started from 1/10/2021 to 1/2/2022, included the examination of blood samples. 30 samples were selected for the surviving patients, and 30 samples for the deceased (the study was conducted in 4 hospitals in different areas in Baghdad), and 30 samples were taken. From apparently healthy people, they represent the group of healthy controls (control), so the total sample of the study was 90 samples, with different ages from 3-69 years. The statistical results showed a significant decrease in the concentration of vitamin D3 in the serum of (recovered) burn patients compared with the standard samples, as its concentration in the serum of recovered patients reached (from 13.09 to 46.76 ng/ml) an average concentration of (28.79 ± 10.51 ng/ml). While its concentration in the standard samples was (from 30.50 to 53.10 ng/ml) with an average concentration of (40.53 ± 6.562 ng/ml), the results showed that there were significant differences between the two concentrations and under the level of probability $P < 0.05$ as the protection value reached <0.0001. The results also showed a significant decrease in the concentration of vitamin D in the serum of

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burn patients (later deceased) compared with the standard samples, as the concentration was found in the serum of deceased burn patients (from 12.62 to 45.67 ng/ml) with an average concentration of (34.02 ± 6.946 ng/ml) compared with The concentration of the standard samples (from 30.50 to 53.10 ng/ml) with an average concentration of (40.53 ± 6.562 ng/ml). The statistical results showed that there were significant differences between the concentration of vitamin D3 for the deceased burn patients and the standard samples under the probability level of $P < 0.05$ as the protection value reached 0.0079.

***Keywords*---**burn patients, bacterial infections, vitamin D, serum, concentration.

Introduction

Early in the 20th century, vitamin D was first identified as a vitamin; it is now understood to be a prohormone (Ross et al., 2011). Vitamin D is available in two common forms: D2 (ergocalciferol) and D3 (Cholecalciferol). Under the impact of UV (type B) rays, vitamin D3 is generated in the skin and can be consumed through diet. While vitamin D2 (ergocalciferol) is primarily obtained through diet, both are hydroxylated in the liver to form [25-hydroxyvitamin D3]], {This form of vitamin D circulates and spreads in the serum and can be measured, that is, analyzes or measuring the level of vitamin D3 that are conducted in laboratories measure the level of concentration (25- hydroxyvitamin D3) in the serum (Holick et al., 2011) }It also turns out, Primarily in the kidneys, to 1,25- dehydroxyvitamin D3 (1,25(OH)2D3), which can bind to vitamin D receptors (VDRs) throughout the body (Rech et al., 2019).

When 7-dehydrocholesterol is exposed to UVB rays, a prohormone called V.D3 is created in the skin. V.D3 is biologically inactive and must first be converted to (25-hydroxyvitamin D3) in the liver and then to (1,25(OH)2D3) in the kidneys in order to function. In order to carry out its several tasks, including calcium absorption, phosphate uptake in the intestine, calcium mobilization and control in the bones, and calcium reabsorption in the kidneys, vitamin D3's hormonal form (1,25(OH)2D3) operates through a nuclear receptor. In addition to maintaining calcium levels in the body, it also serves additional purposes (Maia-Ceciliano et al ., 2019).

It is generally known how crucial vitamin D is for maintaining a healthy calcium balance and strong bones. However, research is starting to show that 25-hydroxyvitamin D3 is crucial for the healthy operation of numerous organs. The optimal level of vitamin D is protective against many chronic diseases, including the risk of systemic infection, cardiovascular disease, lung disease, and diabetes, according to recent scientific clinical research (Zhao et al., 2012) . The Endocrine Society recommended that the serum concentration of 25-hydroxyvitamin D3 (25(OH)D3) be at least 30 ng/mL for optimal health benefits in the same year that the Institute of Medicine reported a serum concentration of 25(OH)D3 at 20 ng/ml (ideal for skeletal health for the US population; Ross et al., 2012). 40–100% of seniors in the US community have been found to be vitamin D deficient, and it is estimated that one (Kepker et al., 2012), while in Iraq it was found that 55% of healthy people suffer from vitamin D deficiency (Mahmmod & Ismael, 2021).

Numerous ailments, ranging from neurological abnormalities to long-term inflammatory conditions, are linked to vitamin D shortage and insufficiency. Lower than 20 ng/mL serum vitamin D values are considered to be deficient. Additionally, vitamin D deficiency is indicated by values between 21 and 29 ng/ml. If serum concentrations are larger than 30 ng/mL, it is considered to be a sufficient or normal value. Numerous Western nations, specifically the United Kingdom, the United States of America, and other European nations, including Greece, have a high frequency of vitamin D insufficiency, according to recent studies. (Karras et al., 2013).

Vitamin D and the Immune System

The finding of vitamin D receptors (VDR) in all types of immune cells, including T-CD4+ and T-CD8+ activated cells, B cells, neutrophils, macrophages, and dendritic cells, provided evidence of the biological and immunological involvement of vitamin D in the human body system. (Kempker et al., 2012) These cells are activated and increased by the body's innate and acquired immune responses to pathogens. Although the relationship between the two has been demonstrated by scientists to be complex, the fundamental problem seems to be the control of the acquired immune response while boosting innate immunity. Vitamin D influences the growth and development of B and T cells as well as the control of immunoglobulin production in terms of acquired immunity (Bartley, 2010).

Rapidly identifying invasive bacteria, the innate immune system reacts with humoral and cellular defense mechanisms to contain, inhibit, neutralize, and eradicate infections. Pathogen-recognition receptors (PRR) in immune cells attach to high-resolution pathogen-associated molecular patterns (PAMP) to identify these pathogens. Neutrophils, monocytes, and epithelial cells that not only serve as an all-encompassing barrier but also have anti-pathogen activity are among the cells that take part in these innate immune responses. A significant part of several immune system pathways is vitamin D. (Baeke et al., 2010 ; Hewison, 2011).

On the other hand, pathophysiology research revealed that the cause of sepsis could be caused by vitamin D deficiency due to a dysfunction in the immune system. Moreover, a decrease in the level of (1,25(OH)2D3) in tissues reduces the regulation and the multidirectional effect on immunity and suppresses mucosal and endothelial function (Upala et al., 2015). Additionally, a number of studies have linked low levels of (25(OH)D3) with unfavorable outcomes in critically sick patients, such as mortality, length of stay (LOS), sepsis, positive blood cultures, and readmission rates. Again (Braun et al., 2012; Quraishi et al., 2014).

The relationship between V.D level and length of hospital stay

Numerous research have been done to determine how vitamin D levels and hospital stay duration relate to one another. Low vitamin D levels in very ill adult and pediatric patients are linked to illness severity, mortality, and length of stay in the unit, according to research done by the Austrian Medical University of Graz on a sample of patients in the intensive care unit. Intensive care or hospitalization, together with a high incidence of sepsis and acute renal failure (Amrein et al., 2014).

Grady Memorial Hospital in the United States did a study, Grady Memorial Hospital The study's findings demonstrated an inverse relationship between severe and mild vitamin D insufficiency and the time spent in the surgical critical care unit. Age, gender, race, and comorbidities (myocardial infarction, acute renal failure, pneumonia) were all taken into account, however the relationship between vitamin D insufficiency and length of stay, surgical ICU costs, and mortality persisted. (Matthews et al ., 2012).

Through the previous studies that we dealt with, it was found that a deficiency of (25(OH)D3) is associated with an increase in the length of stay in the hospital. Burn patients with low levels of (25(OH)D3) have a longer hospital stay than burn patients with normal (25(OH)D3) levels (Rech et al ., 2019; Cho et al., 2020) .

Methods and Materials

200 burn wound swabs were taken from patients who had been admitted to the burn unit at Baghdad City Hospitals in Iraq. Swabs were grown on various media, and colonies were identified based on their phenotypic and culturological traits. Gram staining was used by VITEK® 2 Compact Automated Systems to diagnose the bacteria using cultural characters. There were nine different bacterial isolates in total , Vitamin D level was assessed using an assay kit produced by the English company MY BIOSOURCE, the company that follows the principle of indirect enzyme-linked immunosorbent assay (ELISA).

Results and Discussion

The study sample included 200 burn patients of different ages and gender, 121 patients who survived and recovered (sampling 24 hours before discharge), and 79 patients who died Non survived (sampling 24 hours before death). . Swabs (swabs) were taken for burn wounds, 272 swabs were taken from different areas of the patient’s body (according to the location of the burn and the total surface area of the burn relative to the patient’s body) and the samples were plated on dishes, 182 isolates grew growth and 90 isolates did not have any growth. 30 samples were chosen at random from among the 121 samples of patients who survived, and 30 samples were also chosen randomly from the 79 samples for the deceased, and 30 samples were taken from apparently healthy people representing the healthy controls group (control), for a total of 90 samples for the study.

After transplanting the samples, we found that the samples of burn patients (deceased) that were selected (30 samples) were all associated with Sepsis septicemia with a percentage of 100% in addition to the positive culture result for burn wounds swabs, while the isolated recovered burn patients samples (30 samples) showed that the culture result was positive for wound swabs. Burns only and the result of blood culture is free of Sepsis septicemia, at a rate of 0%.

Vitamin D affected by burns

It is known that burns are considered serious pathological cases, especially if the burns are severe and have a large degree of burning and a relatively large surface area (TBSA). Serious and critical diseases in general have a negative impact on the level of vitamin D3, whether these cases are accompanied by infection or without it (Rousseau et al., 2015).

The current study showed different levels of vitamin D3 or (25(OH)D3) in recovered critically ill burn patients (without septicemia) and deceased critically ill burn patients (diagnosed with septicemia) on one side with the standard sample group on the other, where The statistical results showed a significant decrease in the concentration of vitamin D3 in the serum of (recovered) burn patients compared with the standard samples. as its concentration in the serum of recovered patients reached (from 13.09 to 46.76 ng/ml) with an average concentration of (28.79 ± 10.51 ng/ml). While its concentration in the standard samples was (from 30.50 to 53.10 ng/ml) with an average concentration of (40.53 ± 6.562 ng/ml), the results showed that there were significant differences between the two concentrations and under the level of probability $P < 0.05$ as the protection value reached <0.0001.

The results also showed a significant decrease in the concentration of vitamin D in the serum of burn patients (later deceased) compared with the standard samples, as the concentration was found in the serum of deceased burn patients (from 12.62 to 45.67 ng/ml) with an average concentration of (34.02 ± 6.946 ng/ml) compared with The concentration of the standard samples (from 30.50 to 53.10 ng/ml) with an average concentration of (40.53 ± 6.562 ng/ml). The statistical results showed that there were significant differences between the concentration of vitamin D3 for the deceased burn patients and the standard samples under the probability level of $P < 0.05$ as the protection value reached 0.0079.

The results of the current study showed a significant decrease in the concentration of vitamin D3 or (25(OH)D3) in patients compared to the standard samples. These statistical results were in agreement with the results of the previous study conducted at Emory University on a group of critically ill patients in the unit Intensive care unit (ICU). Where the vitamin D3 status varied in the critically ill persons with sepsis and in the critically without sepsis compared with healthy controls, the differences were highly significant and the $p < 0.0001$ (Jeng et al., 2009). Table No (1-A-) , Figure No (1).

Table (1-A-)
Shows the presence of significant differences in the level of vitamin D for the group of the deceased and the recovered compared to the group of standard samples (Control) under the level of probability $P < 0.05$

A	Mean V.D ng / ml ± SD	Groups Vs . Cont.	
Cont.	Group	Signft .	*P* value
	Recovered 28.79±10.51	**	<0.0001

40.35 ± 6.562	Deceased 34.02 ± 6.946	**	0.0079

* p ≤ 0.05, ** p ≤ 0.01

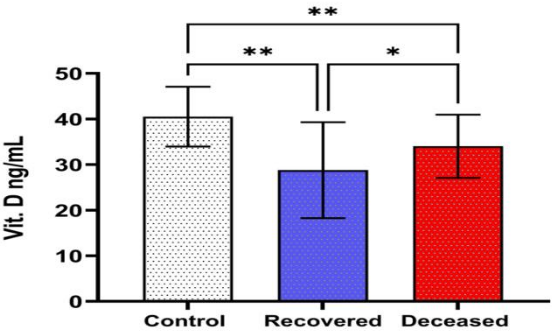

Figure 1 displays the vitamin D levels for the control group, the recovered group, and the deceased group. Significant differences in vitamin D levels between the two groups (recovered & deceased) were found at the probability threshold P< 0.05.

In order to compare the vitamin D concentration of recovered burn patients with that of deceased burn patients, the results showed a decrease in the vitamin D level of recovered burn patients with an average concentration of (10.51 ± 28.79 nano grams / milliliter) compared with the concentration of vitamin in the serum of deceased burn patients with an average concentration of (6.946 ± 34.02 nano grams / milliliters), there are significant differences between the two concentrations and under the level of probability P < 0.05, where the value of protection was 0.0406. Table No (1 –B-) , Figure No (1).

Table (1 –B-)
Shows the presence of significant differences in the level of vitamin D. between the two groups (recovered & deceased) under the level of probability P < 0.05

-B-	Mean V.D ng / ml ± SD Recovered Vs. Decaeased		
Recovered	Deceased	Signft .	*P* value
28.79 ± 10.51	34.02±6.946	*	<0.0406

* p ≤ 0.05, ** p ≤ 0.01

The concentration of vitamin D3 in the group of the recovered (burn wound infection without septicemia) is lower than its concentration in the group of the deceased (with septicemia) and this may be caused by the lack of nutritional supplements and the lack of exposure of patients lying in the hospital to sunlight, in addition to the length of stay in the hospital.

Conclusion

Patients burn with low levels of vitamin D may have more complications such as blood -bacterial and pneumonia due to low ability to fight the enemy as a result of a low vitamin concentration, as we find them, especially at the risk of low levels of (vitamin D) , And when the burn occurs, the level of vitamin D decreases, which negatively affects the state of hospitalization and wound healing, and it is more susceptible to bacterial infections.

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