

Bacterial Organisms Causing Urinary Tract Infection and their Correlation with Vitamin-D Deficiency in Pediatric Patients Presenting at Tertiary Care Hospital in Pakistan

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ABSTRACT

Background: Urinary tract infection is very common among the pediatrics. The systematic effects of vitamin D on the pathogens showed its vital role in immune regulation of the body.

Objective: The study aimed to assess the status of vitamin-D in the children suffering from urinary tract infection.

Study design: It is a cross-sectional study with statistical approach, conducted at HBS Medical and Dental College / HBS General Hospital Islamabad

Material and Methods: The study was conducted on 91 patients visited the pediatric department of the hospital. The study was conducted for six month duration From November 2021 to April 2022. Out of the 91 patients included, the 53 were kept in the experimental group and 38 were kept in the control group. The average age of the patients who participated in this study was 3.86 ± 2.93 years in the case of experimental group while the other hand average age of the patients in the control group was 3.15 ± 3.02 .

Results: For this study, 91 patients were selected. Among these 91 patients, 53 were kept in the experimental group and 38 were kept in the control group. The average age of the patients who participated in this study was 3.86 ± 2.93 years in the case of experimental group while the other hand average age of the patients in the control group was 3.15 ± 3.02 . The patients suffering from some UTI infections have a relatively lower level of vitamin D. For UTI infections, E. coli is the most common agent. However, other microbes are also thought to be the causative agent for this infection like P. aeruginosa, K. pneumonia, S. aureus, etc.

Conclusion: Vitamin D is present in less amount in patients suffering from some urinary tract infections. Therefore a relationship exists between the level of vitamin D and urinary tract infections. Therefore by this study, we can predict that vitamin D therapy can be used to treat UTIs and prevent their repetition. For UTI infections, E. coli is the most common agent. However, there is a need for a large scale study for the more elaborated validations of this study.

Keywords: Vitamin D, urinary tract infection and pediatrics.

INTRODUCTION

Vitamin D not only has the systemic impact on pathogen but it is also essential for immune system regulation. Hypocalcemia cause by vitamin D deficiency can reduce the function of neutrophil and lymphocyte activity. Since vitamin D has many different functions, the most significant is suppression of cytokines, such as the suppression of cytokines (IL6, IL 8). It is also involve in the suppression of the inflammatory cascade that become active after attachment of the pathogen to the uroepithilium. As a result, the severity of UTI reduce and thereby infection effects are suppressed.¹⁻² Vitamin-D deficiency is also linked to influenza sepsis and pneumonia. Some studies has reported the association of vitamin-D deficiency with UTI. It has 20% prevalence around the globe.

Boys are more prone to effected by UTIs than girls. But now it is more common among the girls than boys. Congenital abnormalities of the kidneys and urinary tract (PUV and VUR), constipation, and dysfunction of the bladder are the risk factors for UTI³⁻⁴. The prevalence of UTI is 3%–5% in girls and 1% in boys. UTI is found in about 5% of girls with infancy and 20% of boys. The most commonly observed pathogen (80%–90%) causing UTIs is Escherichia coli infection. Clinical condition of the patients can be improved by taking vitamin D supplements before and during an episode of urinary tract infection. The process vitamin-D supplements are affordable. Antibiotics and vitamin-D supplements can both be used to treat UTI. The misuse of antibiotic can be reduced by this practice. It also lower the management costs Frequent urination, vomiting, fever, dysuria, and hematuria are possible side effects.⁵⁻⁶ This method may lower the misuse of antibiotics and hence lower management costs. The first line of defense against the bacteria is epithelium derived cathelicidin,.

UTI is most commonly observed in the first year of life. Infants with UTIs experience generalized symptoms throughout the first six months of life, particularly fever, vomiting, and decreased activity. The physical examination are not used as diagnostic tool in these young children because of lack of clinical reliable sign at that time.⁷⁻⁸ UTI are effecting number of people especially children around the globe. The limited and insufficient knowledge about the vitamin D deficiency in relation with UTI is available. Therefore this study aimed to predict the relationship between vitamin-D status and UTI⁹⁻¹⁰.

MATERIAL AND METHODS

The study was conducted on 91 patients visited the pediatric department of the hospital. The study was conducted for six month duration From November 2021 to April 2022. The ethical and review board of the hospital approved the study. Out of the 91 patients included, the 53 were kept in the experimental group and 38 were kept in the control group. The average age of the patients who participated in this study was 3.86 ± 2.93 years in the case of experimental group while the other hand average age of the patients in the control group was 3.15 ± 3.02 .

All the patients were aware of the study, they signed the consent. The included children have the age range between 2 to 60 months. The child who received any antibiotic and immunosuppressive drug treatment within 48 hours of the hospital visit were excluded from the study. The high performance liquid chromatography was used for the evaluation of the vitamin D level in the children. The venous blood was taken for the assessment of vitamin D levels. The urine sample of all patients were collected. The SPSS software was used for the statistical analysis.

RESULTS

For this study, 91 patients were selected. Among these 91 patients, 53 were kept in the experimental group and 38 were kept in the control group. The average age of the patients who participated in this study was 3.86 ± 2.93 years in the case of experimental group while the other hand average age of the patients in the control group was 3.15 ± 3.02 . There was no statistical difference observed in the rural and urban area patients. However, patients included in this study, particularly in the experimental group have an average age of 2 or more than two years ($p < 0.010$). The proportion of males to females was kept at 1: 1.3. It was predicted from this study that females are more prevalent to develop urinary tract infections and the infection rate due to their sex is three times more than the control group. The level of vitamin D is also deficient in the experimental group as compared to the control group. However, a normal level of vitamin D was present in the majority of members of the control group. But the patients suffering from some UTI infections have a relatively lower level of vitamin D as shown in table 1.

Table 1: Comparison of experimental and Control sets.

Characteristics	Experimental Group (n = 53)	Control Set (n = 42)	Value of p
Age in years	3.86 ± 2.93	3.15 ± 3.02	0.36
No. of female (%)	32.66	12.87	0.010, OR = 3.024 (1.29–6.17)
No. of Male (%)	24.72	26.72	
Urban circumstantial (%)	31.7	24.9	0.310, OR = 1.63 (0.72–3.65)
Rural circumstantial (%)	27.7	16.8	
25 (OH) vitamin D level (ng/mL; average \pm Standard Deviation)	26.01 ± 14.35	52.96 ± 23.23	<0.010
Vitamin D-Normal range: >30 (ng/miL) (%)	32.5	83.6	<0.010
Vitamin D- deficiency: 20.0 –30.0 ng/miL (%)	31.2	13.3	
Vitamin D- Deficit: <20.0	36.3	0.0	

Table 3:

Age in years	Characteristics	Experimental Group (n = 53)	Control Set (n = 38)	Value of p
Less than 1 (n = 38)	25 (OH) vitamin D range (ng/mL; average \pm Standard Deviation)	35.9 ± 21.9	53.3 ± 14.5	<0.010
	Vitamin D-Normal range: more than 30.0 ng/mL (%)	22.9	5.7	<0.010
	Vitamin D-Inadequacy: (20.0–30.0 ng/mL) (%)	19.6	4.8	
	Female (%)	23.5	17.0	0.12, OR = 3.26 (1.56–8.27)
	Male (%)	17.0	42.5	
1 to 2 (n = 22)	25 (OH) vitamin D range (ng/mL; average \pm Standard Deviation)	33.8 ± 14.8	48.4 ± 27.1	0.161
	Vitamin D-Normal range: more than 30.0 ng/mL (%)	33.5	36.5	0.57
	Vitamin D-Inadequacy: (20.0–30.0 ng/mL) (%)	12.8	11.5	
	Vitamin D-Inadequacy: less than 20.0 ng/mL (%)	4.3	0.0	0.030, OR = 2.7 (1.23–6.21)
	Female (%)	32.3	17.7	
Male (%)	19.7	27.3		
More than 2 (n = 33)	25 (OH) vitamin D range (ng/mL; average \pm Standard Deviation)	17.6 ± 7.1	37.8 ± 8.7	<0.010
	Vitamin D-Normal range: more than 30.0 ng/mL (%)	2.81	26.8	<0.010
	Vitamin D-Inadequacy: (20.0–30.0 ng/mL) (%)	12.9	5.56	
	Vitamin D-Inadequacy: less than 20.0 ng/mL (%)	51	0.0	0.90, OR = 0.72 (0.312–1.63)
	Female (%)	26.9	17.6	
Male (%)	37.9	17.6		
ANNOVA test for the contrast of the three age categories (vitamin D range)				
		Experimental group	<0.010	
		Control Set	0.081	
Experimental group	First experience of UTIs (n = 16)	Repeated UTIs (n = 38)		
25(OH)vitamin D levels	28.65 ± 11.75	22.82 ± 13.91		0.039

For UTI infections, E. coli is the most common agent. However, other microbes are also thought to be the causative agent for this infection like P. aeruginosa, K. pneumonia, S. aureus, etc.

ng/miL (%)			
Age more than 1.0 years (%)	17.8	23.2	<0.010
Age 1 to 2 years (%)	12.9	8.8	
Age more than two years (%)	30.5	7.7	

In table 2, the relation between temperature, age, and different biochemical and hematological characteristics of the experimental group were shown. No significant ascending or descending pattern was observed.

Table 2: Variables correlation in the Experimental group;

Inconstant	R-value	Serum 25(OH) vitamin D Levels- Value of p
Age in years	-0.51	<0.010
Temp (°C)	0.20	0.13
ESR value (mm/h)	-0.010	0.88
No of Leukocytes per μ L	0.029	0.83
Erythrocytes $\times 10^6$ per μ L	-0.22	0.12
Hgb value (g/dL)	-0.16	0.16
Htc value (%)	-0.23	0.081
MEV value (fL)	-0.089	0.46
No. of Platelets per μ L	0.021	0.83
No. of Neutrophils (%)	-0.019	0.82
No. of Lymphocytes (%)	0.010	0.83
No. of Monocytes (%)	0.12	0.32
Calcium content (mmol/L)	0.44	<0.010
Magnesium content (mmol/L)	0.20	0.17
Iron content (μ mol/L)	-0.019	0.86
Phosphorus content (mmol/L)	0.04	0.87
AST level (U/L)	0.26	0.060
ALT level (U.L)	0.16	0.26
Urea content (mg/dL)	-0.10	0.43
Creatinine level (mg/dL)	-0.22	0.091

In table 3, the level of vitamin D in relation to UTI infection is narrated. The sex-wise changes in the level of vitamin D are also demonstrated in this table.

DISCUSSION

Vitamin D plays an important role in the development of the skeleton apart from this it also has role in a number of infectious diseases in children. Several infections like tuberculosis, respiratory and digestive pathway infections and acute otitis can be prevented by vitamin D therapy. However, excess vitamin D is also a reason for some critical issues¹¹⁻¹². The more accurate function of DBP is to maintain the level of free circulating and bounded vitamin D and its metabolites. About 0.03 % of the derivatives remain free circulating while the left of it remains bounded to the albumin. DBP is multifunctional and has a number of roles including transport of vitamin D. Kidney issues like injury of the kidney, syndrome of nephrons, tubular acidosis, tubular necrosis, and chronic issues of the kidney affect the transporting capability of DBP from the filtrate to renal tubules. This is the exact reason behind the deficiency of vitamin D in a number of infections¹³⁻¹⁵.

The major limitation of this study is that we are unable to estimate the level of DBP because we cannot see insight into the genetics, these results are only predicted by observing the general features of the disease and secondary reasons for DBP defects. In this study, a correlation was found between lower amounts of vitamin D and hypocalcemia. The amount of absorption of calcium from the intestine is equivalent to the presence of an optimal level of vitamin D. When a slightly lower level of vitamin D is present, then parathormone gets activated to fulfill the concentration of calcium within the body. So the level of this hormone is also considered a biomarker for the determination of vitamin D within the body but there is a need for supplementation of cholecalciferol for normalization. However, recent studies revealed that the level of parathormone relates to the freely available vitamin D, not the total amount¹⁶.

The consequences of vitamin D are more elaborately studied in urothelium because it has a role in innate immunity. The correlation between vitamin D and UTIs in children is widely studied. Whenever there is less amount of vitamin D, it may lead to these types of infections of the urinary tract. In china, a meta analysis of nine populations of children was studied and it was inferred that the lower level of vitamin D is the reason behind UTIs. This study also favors the concept that UTI infections occur due to the lower level of freely available vitamin D in the serum but some groups claim that when such UTI patients are appended with vitamin D the propagation of infecting bacteria increases which may lead to the nephrocalcinosis, an optimized dose of vitamin D can be used for the treatment of UTI¹⁷⁻¹⁸. In this study, the level of vitamin D get lowers when the infection of the urinary tract is present. The level of vitamin D is not related to age and this fact is not consistent with the other studies. The children included in this study are provided with vitamin D till the age of 2 years. The national guidelines permit the supplementation of vitamin D till 18 months of age. Usually, winter season prophylaxis is appropriate after this age. Thus vitamin D can also be obtained by sun basking. The supplementation of vitamin D should be more than the normal range in the case of artificial intake¹⁹⁻²⁰.

Like other studies, in this study, the main reason behind UTIs is *E. coli*. About 86 % of infection is due to *E. coli*. A study was performed on mice suffering from some UTI, then the link between the pathogenic bacterium and VRD level was studied. Vitamin D is considered a necessary component for the transcription of VRD otherwise up-regulation of VRD may take place. The mice had a lower level of vitamin D have more abrasive UTIs. So we can say that a normal level of vitamin D can help to prevent UTIs²¹. This study also emphasizes congenital abnormalities. The abnormality of genitals has a prime role in the invasion of infection but does not have a direct effect on lowering the level of vitamin D in the serum. However, for further validation of this fact, there is a need for a large experimental group unlike the group included in this study²².

CONCLUSION

Vitamin D is present in less amount in patients suffering from some urinary tract infections. Therefore a relationship exists between the level of vitamin D and urinary tract infections. Therefore by this study, we can predict that vitamin D therapy can be used to treat UTIs and prevent their repetition. In this study congenital abnormalities have an effect the occurrence of UTI but not on the level of vitamin D.

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