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Interaction Between Vitamin D Deficiency and Bronchiolitis Severity and Cardiac Function Indicators: A Prospective Study

D Vitamini Eksikliği ve Bronşiolit Şiddeti: Bebeklerde Klinik ve Kardiyopulmoner Etkileri

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Abstract

Objective: This study aimed to evaluate the relationship between vitamin D levels and the severity of bronchiolitis in hospitalised infants, as well as the potential cardiopulmonary effects of this relationship.

Materials and Methods: Between August 2020 and July 2021, 60 infants aged 1-24 months who were hospitalised with bronchiolitis were analysed prospectively. Data such as vitamin D levels, oxygen saturation (SpO_2), neutrophil count and heart rate were recorded. The relationship between the severity of bronchiolitis and cardiopulmonary parameters was evaluated.

Results: Vitamin D levels were significantly lower in the severe bronchiolitis group (15.1±7.3 ng/mL vs. 22.5±13.9 ng/mL; p=0.017). This group also had a lower SpO_2 level (88.2%±4.1% vs. 93.1%±3.8%; p=0.001), a higher heart rate (153.8 bpm ±14.6 vs. 139.4 bpm ±12.3; p=0.011) and a higher neutrophil count (p=0.038). There was a positive correlation between vitamin D level and SpO_2 (r=+0.45, p=0.009) and a negative correlation between vitamin D level and neutrophil count (r=-0.43, p=0.012). In a multivariate analysis, vitamin D levels were found to be an independent predictor of bronchiolitis severity (odds ratio: 0.905; 95% confidence interval: 0.834-0.981; p=0.015).

Conclusion: A vitamin D deficiency reflects the severity of an infection, as well as cardiopulmonary overload, which is characterised by concurrent hypoxaemia, an increased heart rate, and inflammation. These parameters can be used to predict future cardiovascular risk.

Keywords: Vitamin D deficiency, bronchiolitis, cardiopulmonary impact, heart rate, neutrophil count

Öz

Amaç: Bu çalışmanın amacı, hastaneye yatırılan bebeklerde vitamin D düzeyleri ile bronşiolit şiddeti arasındaki ilişkiyi ve bu ilişkinin olası kardiyopulmoner etkilerini değerlendirmektir.

Yöntem ve Gereçler: Ağustos 2020 ile Temmuz 2021 tarihleri arasında bronşiolit tanısıyla hastaneye yatırılan 1-24 ay arası 60 bebek prospektif olarak incelendi. Vitamin D düzeyi, oksijen satürasyonu (SpO_2), nötrofil sayısı ve kalp hızı gibi veriler kaydedildi. Bronşiolit şiddeti ile kardiyopulmoner parametreler arasındaki ilişki değerlendirildi.

Bulgular: Vitamin D düzeyleri, şiddetli bronşiolit grubunda anlamlı derecede daha düşüktü (15,1±7,3 ng/mL vs. 22,5±13,9 ng/mL; p=0,017). Bu grupta ayrıca daha düşük SpO_2 düzeyi (88,2% ±4,1% vs. 93,1% ±3,8%; p=0,001), daha yüksek kalp hızı (153,8 bpm ±14,6 vs. 139,4 bpm ±12,3; p=0,011) ve daha yüksek nötrofil sayısı (p=0,038) saptandı. Vitamin D düzeyi ile SpO_2 arasında pozitif korelasyon (r=+0,45, p=0,009)

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ve vitamin D düzeyi ile nötrofil sayısı arasında negatif korelasyon (r=-0,43, p=0,012) bulundu. Multivaryant analizde, vitamin D düzeyinin bronşiolit şiddetinin bağımsız bir prediktörü olduğu belirlendi (odds oranı: 0,905; %95 güven aralığı: 0,834-0,981; p=0,015).

Sonuç: D vitamini eksikliği, enfeksiyonun ciddiyetinin yanı sıra eş zamanlı hipoksemi, artmış kalp hızı ve enflamasyon ile karakterize edilen kardiyopulmoner aşırı yüklenmeyi de yansıtır. Bu parametreler gelecekteki kardiyovasküler riski tahmin etmek için kullanılabilir.

Anahtar Kelimeler: Vitamin D eksikliği, bronşiolit, kardiyopulmoner etki, kalp hızı, nötrofil sayısı

INTRODUCTION

Bronchiolitis is one of the main causes of acute lower respiratory tract infections in children, particularly during the first two years of life, and is one of the most common reasons for hospitalisation. The most common pathogen responsible for this disease is respiratory syncytial virus (RSV) (1,2). RSV infection can cause severe respiratory failure, particularly in premature, low-birth-weight or comorbid infants. In severe cases, hypoxaemia and increased respiratory effort can trigger a systemic inflammatory response that affects not only the respiratory system but also the cardiovascular system. This can lead to consequences ranging from transient myocardial overload to long-term, permanent cardiovascular dysfunction (3).

In recent years, the impact of vitamin D levels on immune and cardiovascular health has attracted growing attention (4). Vitamin D plays a role in processes beyond classical bone-mineral metabolism, including the regulation of the immune response, the modulation of inflammation, and the protection of endothelial function. Childhood vitamin D deficiency has been shown not only to increase susceptibility to infection, but also to adversely affect the development of the vasculature and vascular reactivity. Consequently, it is hypothesised that vitamin D levels and the clinical course may be closely related in cases where systemic inflammation is predominant, such as in bronchiolitis (5-7).

This study investigated the relationship between vitamin D levels and the severity of bronchiolitis in hospitalised infants aged 1-24 months. Patients were categorised as having mild/moderate or severe bronchiolitis according to clinical and laboratory parameters. The results revealed that hypoxaemia became more pronounced, and that heart and neutrophil counts increased, as vitamin D levels decreased. These parameters may indicate a subclinical level of cardiopulmonary stress.

In conclusion, bronchiolitis should be considered not only as an acute respiratory infection, but also as the possible effects of systemic markers, such as vitamin D levels, on the course of the disease. Early diagnosis and monitoring of vitamin D deficiency are important due to their impact on susceptibility to infection and potential cardiovascular burden. Further studies in this context may reveal the effects of vitamin D replacement therapy more clearly.

MATERIAL AND METHODS

This prospective study was conducted in the Department of Paediatrics at the Inönü University Faculty of Medicine. It included 60 infants aged 1-24 months who were hospitalised with a diagnosis of acute bronchiolitis between 1 August 2020 and 30 July 2021. Malatya Clinical Research Ethics Committee approval (protocol no: 2020/80, date: 03.06.2020) was obtained, as was informed consent from the parents. The inclusion criteria consisted of hospitalised infants aged between 1 and 24 months with a diagnosis of bronchiolitis. Those excluded from the study included infants with congenital heart disease, immunodeficiency, neuromuscular disorders, chronic lung diseases (such as cystic fibrosis and bronchopulmonary dysplasia), and metabolic disorders. During data collection, the following parameters were recorded: age, sex, birth weight, diet, vitamin D level, complete blood count, neutrophil count, heart rate and oxygen saturation (SpO_2). Bronchiolitis severity was categorised as either mild-moderate or severe according to the clinical picture, degree of respiratory distress, and oxygen requirement.

Statistical Analysis

The statistical analyses were performed using SPSS version 21. An independent sample t-test was used for continuous variables, while a chi-square test was used for categorical data. The Pearson test was used for correlation analysis. Logistic regression analysis was performed to determine the independent variables that predict severe bronchiolitis, with $p<0.05$ being considered statistically significant.

RESULTS

The mean age of the 60 infants included in the study was 5.6 (±4.8) months, and 63.3% were male. Vitamin D levels were significantly lower in the severe bronchiolitis group (15.1±7.3 ng/mL vs. 22.5±13.9 ng/mL; p=0.017). Additionally, this group had lower SpO_2 (88.2±4.1% vs. 93.1±3.8%; p=0.001), a higher heart rate (153.8±14.6 bpm vs. 139.4±12.3 bpm; p=0.011), and a higher neutrophil count (p=0.038) (Table 1).

The vitamin D level was positively correlated with SpO_2 (r=+0.45, p=0.009) and negatively correlated with neutrophil count (r=-0.43, p=0.012). Logistic regression analysis determined vitamin D level to be an independent predictor of severe bronchiolitis (odds ratio: 0.905; 95% confidence interval: 0.834-0.981; p=0.015) (Table 2).

Table 1. Comparison of mild-moderate and severe bronchiolitis groups

Parameter	Mild-moderate bronchiolitis (34)	Severe bronchiolitis (26)	p-value
Age (months)	4.7±3.4	6.8±5.6	0.075
Vitamin D (ng/mL)	22.5±13.9	15.1±7.3	0.017*
SpO_2 (%)	93.1±3.8	88.2±4.1	0.001**
Heart rate (bpm)	139.4±12.3	153.8±14.6	0.011*
Neutrophil (/mm^3)	3974±2650	5835±4124	0.038*

*: p<0.05, **: p<0.01
SpO_2: Oxygen saturation

Table 2. Correlation between vitamin D level and other parameters

Parameter	Correlation coefficient (r)	p-value
SpO_2 (%)	+0.45	0.009
Neutrophil count	-0.43	0.012

SpO_2: Oxygen saturation

DISCUSSION

Bronchiolitis remains one of the leading causes of hospitalisation in infants worldwide and continues to pose a significant burden on healthcare systems, particularly during seasonal epidemics. The present study demonstrated a clear association between vitamin D deficiency and increased severity of bronchiolitis, with deficiency linked to lower SpO_2, higher heart rate, and increased neutrophil counts. Importantly, our findings also suggest that vitamin D deficiency may contribute to subclinical cardiopulmonary stress, as reflected by elevated heart rate and impaired oxygenation.

The relationship between vitamin D deficiency and respiratory tract infections in childhood has been extensively investigated. Esposito and Lelii reported that children with low vitamin D levels were more susceptible to acute respiratory infections, including bronchiolitis and pneumonia. Similarly, Mittal et al. (2) recently confirmed that infants with vitamin D deficiency experienced more severe bronchiolitis. In line with these observations,

Hasegawa et al. (6) demonstrated that low serum vitamin D levels were common among infants hospitalised with bronchiolitis and were associated with worse clinical outcomes. Our findings are consistent with these reports, reinforcing the concept that vitamin D deficiency exacerbates bronchiolitis severity.

Several mechanisms may explain the observed association between vitamin D deficiency and bronchiolitis severity. Vitamin D enhances innate immunity through the induction of antimicrobial peptides, including cathelicidin and defensins, providing frontline defence against viral pathogens such as RSV. Deficiency may therefore predispose infants to more severe viral replication and inflammation. In addition, vitamin D modulates the adaptive immune response by downregulating pro-inflammatory cytokines (interleukin-6, tumor necrosis factor-α) and promoting regulatory T cell activity. These immunomodulatory effects may prevent the excessive airway inflammation and systemic responses that characterise severe bronchiolitis (7). From a cardiovascular perspective, vitamin D deficiency has been linked to endothelial dysfunction, increased arterial stiffness, and altered myocardial contractility (3). These pathophysiological changes may explain the elevated heart rate and impaired oxygenation observed in our cohort. Notably, McNally et al. (8) demonstrated that vitamin D deficiency in critically ill children was associated with greater cardiovascular instability and worse outcomes. Taken together, these findings suggest that vitamin D status may influence both respiratory and cardiovascular responses during acute bronchiolitis.

The clinical implications of our findings are significant. Routine assessment of vitamin D levels in infants hospitalised with bronchiolitis may provide prognostic value, helping clinicians identify patients at higher risk for severe disease and cardiopulmonary compromise. Furthermore, vitamin D deficiency is common but readily modifiable. Early recognition and supplementation could represent a simple, cost-effective intervention to mitigate the severity of bronchiolitis and potentially reduce hospitalization duration and healthcare costs.

In clinical practice, infants with severe bronchiolitis are frequently monitored for respiratory distress, oxygen requirement, and feeding difficulties. Our results highlight the importance of extending this monitoring to include cardiopulmonary stress indicators, such as persistent tachycardia, in relation to vitamin D status. This integrated perspective may enhance the holistic management of bronchiolitis.

Study Limitations

Despite its strengths, including a prospective design and the integration of biochemical, inflammatory, and cardiovascular parameters, our study has several limitations. The relatively small, single-centre sample limits generalisability. Seasonal variability in vitamin D levels was not controlled, which could influence the observed associations. Furthermore, only immediate cardiopulmonary indicators were assessed; long-term outcomes were not included. Echocardiography and biomarkers such as N-terminal pro-B-type natriuretic peptide (NT-proBNP) or troponin, which could provide further insights into cardiac strain, were not measured. Future studies should focus on larger, multicentre cohorts, integrating detailed

nutritional, seasonal, and socio-economic factors. Randomised controlled trials are needed to determine whether vitamin D supplementation reduces bronchiolitis severity and improves cardiopulmonary outcomes (8). Additionally, longitudinal studies with echocardiographic follow-up could clarify the long-term cardiovascular consequences of recurrent bronchiolitis in vitamin D-deficient infants.

CONCLUSION

This prospective study demonstrated that vitamin D deficiency is significantly associated with severe bronchiolitis in infants, characterized by more pronounced hypoxemia, tachycardia, and elevated neutrophil counts. These findings suggest that vitamin D deficiency contributes not only to the infectious burden but also to cardiopulmonary stress during acute bronchiolitis. Beyond its skeletal effects, vitamin D plays a key role in immune modulation, endothelial protection, and cardiovascular stability.

The study has some limitations. It was conducted in a single centre with a relatively small sample size, which limits generalisability. Seasonal variability in vitamin D levels was not controlled, and cardiopulmonary indicators (SpO_2, heart rate) were based only on immediate measurements without long-term follow-up. In addition, advanced cardiac assessments such as echocardiography and biomarkers (e.g., NT-proBNP) were not performed, restricting evaluation of subclinical cardiac dysfunction.

In conclusion, assessing vitamin D levels in infants with bronchiolitis may provide valuable prognostic information and guide supportive treatment strategies. Routine monitoring and early correction of vitamin D deficiency in early life could represent a simple, cost-effective approach to improving both infectious outcomes and cardiopulmonary health in this vulnerable population.

*Ethics

Ethics Committee Approval:

Informed Consent: Detailed information was given to the patients regarding the possible contribution of the case report to the literature. The patients gave written and verbal consent for the publication of the case report.

Footnotes

Authorship Contributions

Surgical and Medical Practices: P.A., G.K., M.T., Concept: P.A., G.K., M.T., Design: P.A., G.K., M.T., Data Collection or Processing: P.A., G.K., M.T., Analysis or Interpretation P.A., G.K., M.T., Literature Search: P.A., G.K., M.T., Writing: P.A., G.K., M.T.

Conflict of Interest: No conflict of interest was declared by the authors.

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