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The Impact of Vitamin B12 Deficiency on Type 2 Diabetes Patients: An Observational Study of 100 Cases

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Abstract
Vitamin B12 deficiency is a common yet underdiagnosed condition in individuals with Type 2 Diabetes Mellitus (T2DM), especially those on long-term metformin therapy. This study aims to evaluate the prevalence and effects of vitamin B12 deficiency in a cohort of 100 T2DM patients. Data analysis revealed a significant correlation between B12 deficiency and neuropathy, fatigue, and other metabolic disturbances. These findings emphasize the need for regular monitoring of vitamin B12 levels in T2DM management.

Keywords: Vitamin B12 deficiency, Type 2 Diabetes Mellitus, neuropathy, metformin, patient outcomes

Introduction
Vitamin B12, also known as cobalamin, plays a critical role in hematological, neurological, and metabolic functions. Deficiency of this vitamin can cause neurological complications, macrocytic anemia, and metabolic derangements. In patients with Type 2 Diabetes Mellitus (T2DM), vitamin B12 deficiency often remains underdiagnosed, despite its potential to exacerbate diabetes-related complications such as neuropathy.

Metformin, a first-line therapy for T2DM, is associated with malabsorption of vitamin B12. This issue becomes increasingly significant given the global rise in T2DM prevalence. The objective of this study is to assess the clinical and biochemical impacts of vitamin B12 deficiency in T2DM patients, based on observations from 100 cases.

Materials and Methods
Study Design
This is a cross-sectional observational study conducted in a tertiary care hospital over 12 months. The study included 100 patients diagnosed with T2DM, selected through systematic sampling.

Inclusion and Exclusion Criteria
• Inclusion criteria: Patients aged 30–70 years with T2DM for at least five years, receiving oral hypoglycemic therapy (primarily metformin).
• Exclusion criteria: Patients with chronic renal failure, anemia of other etiologies, or concurrent autoimmune disorders.

Data Collection
1. Clinical Evaluation: A detailed history was obtained, focusing on symptoms like fatigue, neuropathy, paresthesia, and gait disturbances.
2. Biochemical Assessment: Blood samples were analyzed for vitamin B12 levels, fasting glucose, HbA1c, homocysteine, and complete blood count.
3. Neurological Examination: Nerve conduction studies were performed to evaluate diabetic peripheral neuropathy (DPN).

Vitamin B12 deficiency was defined as serum levels <200 pg/mL. Borderline levels (200–300 pg/mL) were monitored for clinical symptoms and biochemical changes.

Statistical Analysis
Data were analyzed using SPSS software. Associations were determined using chi-square tests for categorical variables and Pearson correlation for continuous variables.

Results
Demographics
The mean age of the cohort was 55 years, with 52% male and 48% female patients. The average duration of diabetes was 9.5 years.

Prevalence of Vitamin B12 Deficiency
Out of 100 patients:

• 38% had vitamin B12 deficiency (<200 pg/mL).
• 24% exhibited borderline deficiency (200–300 pg/mL).
• Only 38% had normal vitamin B12 levels.

Correlation Between Vitamin B12 Levels and Metformin Use
Among the 80 patients on metformin therapy, 70% had either deficiency or borderline deficiency. This was significantly higher compared to non-metformin users ($p < 0.05$).

Clinical Manifestations
Patients with vitamin B12 deficiency reported the following symptoms more frequently than those with normal levels:
• Neuropathy: 76% (vs. 28% in non-deficient patients)
• Fatigue and Weakness: 58% (vs. 18%)
• Cognitive Impairment: 22% (vs. 8%)

Neurological Examination
Nerve conduction studies showed a higher incidence of DPN in the deficient group (64%) compared to those with normal levels (30%).

Biochemical Alterations
Patients with B12 deficiency had elevated homocysteine levels (mean: 18.2 μmol/L) compared to those without deficiency (mean: 10.4 μmol/L).

Discussion
Association Between T2DM and Vitamin B12 Deficiency
The findings confirm a strong association between metformin use and reduced vitamin B12 levels. This is consistent with previous studies suggesting that metformin interferes with vitamin B12 absorption in the ileum.

Implications for Diabetic Neuropathy
Neuropathy is a common complication of T2DM, often attributed to poor glycemic control. However, the present study highlights that vitamin B12 deficiency can independently exacerbate neuropathic symptoms. This underscores the importance of distinguishing between diabetic neuropathy and B12 deficiency-induced neuropathy for effective management.

Metabolic Impact
Hyperhomocysteinemia, a hallmark of vitamin B12 deficiency, has been linked to cardiovascular complications in diabetes. Elevated homocysteine levels in deficient patients suggest an increased risk of vascular events, necessitating early detection and intervention.

Management Strategies
Given the high prevalence of deficiency, routine screening of vitamin B12 levels in T2DM patients, particularly those on long-term metformin therapy, is recommended. Supplementation with intramuscular or high-dose oral vitamin B12 can significantly improve clinical outcomes.

Conclusion
Vitamin B12 deficiency is highly prevalent among T2DM patients, particularly those on metformin therapy. The deficiency contributes to increased neuropathic symptoms, fatigue, and metabolic disturbances, thereby aggravating diabetes-related complications. Regular screening and prompt supplementation should be integral to T2DM management protocols.

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