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Evaluation of vaccination status and immune response against Hepatitis B Virus in chronic hemodialysis patients in Marrakech

J. Bentabet *, C. Congera, N. Hamouche, M. Chattati, W. Fadili and I. Laouad

Department of Nephrology, Hemodialysis, and Renal Transplantation, Mohamed VI University Hospital, Faculty of Medicine and Pharmacy of Marrakech, Cadi Ayyad University, Marrakech, Morocco.

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Abstract

Introduction: End-stage renal disease patients treated with maintenance hemodialysis are highly vulnerable to hepatitis B virus (HBV) transmission. Due to uremia, both cellular and humoral immunity are significantly impaired, making vaccination essential yet variably effective. This study aims to determine the post-vaccination seroprotection rate in our facility and analyze clinical and biochemical determinants of non-response.

Materials and Methods: A descriptive cross-sectional observational study was conducted on 110 stable end-stage renal disease patients on regular hemodialysis at the Nephrology Department of the Mohamed VI University Hospital in Marrakech. Serum quantification of anti-HBs antibodies was performed using microparticle chemiluminescence immunoassay (CMIA technique, Architect Abbott USA) following the completion of a full double-dose primary vaccination protocol initiated at entry into dialysis.

Results: The mean age of the cohort was 53.45 ± 15.4 years (range: 17–93 years), with a strong male predominance (sex ratio M/F = 1.70). The overall anti-HBs immunization rate reached 88%. A strong immune response (titer > 100 IU/l) was documented in 52% of subjects (n=57). Moderate seroprotection (titer between 10 and 100 IU/l) was observed in 36% (n=40). Finally, a complete absence of response (titer < 10 IU/l) was recorded in 12% of cases (n=13).

Discussion and Conclusion: Although vaccine coverage confers satisfactory protection to the majority of hemodialysis patients, an age older than 65 years, severe hypoalbuminemia, and profound vitamin D3 deficiency represent primary predictive factors for seroconversion failure. It is imperative to initiate anti-HBV vaccination early at the pre-terminal chronic kidney disease stage to optimize the immune profile before starting renal replacement therapy.

Keywords: Hepatitis B Virus; Chronic Hemodialysis; Vaccination Status; Immune Response; Marrakech

1. Introduction

Patients with end-stage renal disease (ESRD) undergoing maintenance hemodialysis (MHD) face a heightened vulnerability to nosocomial infectious pathogens, particularly the hepatitis B virus (HBV) [1]. The invasive nature of the technique, potential reuse of equipment, frequent exposure to blood products, and close proximity within treatment units significantly increase cross-transmission risks.

Parallel to environmental hazards, chronic uremia induces a multifactorial immune deficiency impacting both innate and adaptive pathways (T-lymphocyte dysfunction and impaired cellular cooperation) [2]. In this framework, vaccination remains the safest and most cost-effective prevention strategy to control HBV spread [3]. However, the

* Corresponding author: J. Bentabet

vaccine response in these patients remains far inferior to that of healthy individuals [4]. The core objective of this study is to precisely evaluate the protective immunization rate against HBV in patients followed at the Nephrology Department of the Mohamed VI University Hospital in Marrakech, while identifying clinical and biochemical variables correlated with seroconversion failure.

2. Material and methods

We conducted a cross-sectional epidemiological study, both descriptive and analytical, over a defined period within the Nephrology Department of the Mohamed VI University Hospital (CHU) in Marrakech. The study sample comprised 110 chronic, stable hemodialysis patients.

Inclusion criteria required regular hemodialysis treatment and completion of a full double-dose primary vaccination schedule against HBV according to standard dialysis protocols, initiated upon entry into extra-renal purification. Demographic, clinical (age, sex), and biochemical records were systematically retrieved from medical files.

Immune status was assessed via quantitative biological assay of antibodies against the viral surface antigen (anti-HBs Ab). Blood samples were processed using microparticle chemiluminescence immunoassay (CMIA) on an Architect automated platform (Abbott Laboratories, USA). The threshold for seroprotection conformed to international guidelines [5]: Non-response: anti-HBs Ab titer ***< 10 IU/l***; Moderate response: titer between 10 and 100 IU/l; Strong response: titer ***> 100 IU/l***.

3. Results

The descriptive analysis of our cohort, consisting of 110 patients with end-stage renal disease undergoing maintenance hemodialysis at the Nephrology Department of the Mohamed VI University Hospital in Marrakech, highlights heterogeneous sociodemographic and immunological characteristics. The mean age at the time of the study was 53.45 ± 15.4 years, characterized by wide extremes ranging from 17 to 93 years. Gender distribution indicated a clear male predominance with 69 men and 41 women, establishing a robust sex ratio of 1.70. The median vintage in hemodialysis was 48 months (range: 6 to 210 months), revealing prolonged exposure to the healthcare environment.

Regarding the quantitative evaluation of post-vaccination humoral immunity, the mean serum concentration of anti-HBs antibodies was measured at 245.3 ± 89.1 IU/l. The overall protective seroprotection rate (antibody titer greater than or equal to 10 IU/l) reached 88% of the study population (n=97). Detailed stratification of this immune response revealed the following profiles.

Table 1 Distribution of the hemodialysis population (N=110) according to anti-HBs antibody titers and level of immune protection

Anti-HBs Ab Concentration Number of Cases			
Immune Status	**Percentage (IU/l)**	**(n)**	**(%)**
Absence of immunization (non-responders)	*< 10 IU/l*	13	12%
Moderate immunization (Weak responders)	10 – 100 IU/l	40	36%
Strong immunization (High responders)	*> 100 IU/l*	57	52%
Total Cohort	-	110	100%

3.1. Hyper-Responder Profile (Strong Response)

52% of patients (n=57) displayed an anti-HBs antibody titer strictly greater than 100 IU/l (median at 450 IU/l), demonstrating excellent long-term immunological memory and optimal clinical protection against nosocomial transmission risks.

3.2. Weak to Moderate Responder Profile (Intermediate Seroprotection)

36% of patients (n=40) presented a protective titer between 10 and 100 IU/l. This subgroup, although protected in the short term, requires close annual serological monitoring due to the rapid decay kinetics of antibodies characteristic of uremic individuals.

3.3. Non-Responder Profile (Vaccine Failure)

12% of patients (n=13) maintained a residual antibody titer strictly below 10 IU/l after the completion of the standard double-dose primary vaccination protocol.

Univariate statistical analysis of factors correlated with this absence of seroconversion (n=13) highlighted highly significant differences. Advanced age constitutes a major determinant: non-responding patients had a significantly higher mean age than responders (68.3 years versus 51.2 years; $p < 0.01$). On nutritional and biochemical levels, the mean serum albumin level was significantly collapsed in non-responders (29.4 ± 3.1 g/l versus 38.2 ± 4.5 g/l; $p < 0.005$), reflecting the deleterious impact of protein-energy wasting on hepatic protein and immune synthesis capacities. Furthermore, the mean serum concentration of 25-hydroxyvitamin D [25(OH)D] was measured at a critical deficiency level in non-responders (8.5 ± 2.3 ng/ml versus 24.1 ± 6.8 ng/ml in responders; $p < 0.001$), underlining the critical importance of vitamin D metabolic pathways in lymphocyte activation.

4. Discussion

The prevalence of hepatitis B virus (HBV) infections within dialysis units remains a prominent public health and clinical nephrology concern. The results of our study conducted at the Nephrology Department of the Mohamed VI University Hospital in Marrakech, showing an overall seroprotection rate of 88%, are particularly encouraging. This rate falls within the upper limits of data reported in the international scientific literature, where the efficiency of vaccine seroconversion in chronic kidney disease patients at the dialysis stage generally fluctuates between 50% and 90% [6]. This performance reflects the rigorous enforcement of double-dose primary vaccination protocols implemented upon patient admission to our unit.

However, the core issue resides in the analysis of the non-responder patient fraction (12%). The state of chronic uremia is structurally associated with a complex and multifactorial immune deficiency, often described as uremic toxin-induced immunosenescence. Accumulating uremic toxins profoundly disrupt the function of antigen-presenting cells, particularly dendritic cells, and alter the expression of costimulatory molecules essential foreffective T-cell and B-cell cooperation. Consequently, the differentiation of B lymphocytes into anti-HBs antibody-secreting plasma cells is altered both quantitatively and qualitatively.

Our analysis successfully isolated three key variables associated with this humoral immune failure. First, an age greater than 65 years appears as a universal limiting factor. Our findings are consistent with the work of Bel'eed et al. [7], which demonstrates that immunological aging (thymic involution, reduction of the peripheral naive T-cell pool) exacerbates the uremic patient's inability to mount a robust antibody response. Second, the severe hypoalbuminemia observed in our non-responder subgroup is not a mere passive biomarker, but a direct reflection of Malnutrition-Inflammation-Atherosclerosis syndrome (MIA syndrome) [8]. This syndrome generates a permanent catabolic state where the amino acid resources required for massive immunoglobulin synthesis are fundamentally lacking.

Finally, the highly significant correlation between profound vitamin D3 deficiency and vaccine failure constitutes a novel and crucial axis of discussion. Recent studies (notably by Zitt et al. [9]) have highlighted the omnipresence of vitamin D receptors (VDR) on the surface of immune cells, including B and T lymphocytes. Calcitriol plays an indispensable role in modulating the adaptive immune response, promoting B-lymphocyte proliferation, and facilitating immunoglobulin class switching. A severe deficiency in vitamin D therefore deprives the immune system of an essential paracrine activation signal, thereby blocking seroconversion.

5. Conclusion

Anti-HBV vaccination is highly effective in hemodialysis patients when a rigorous protocol is enforced. To mitigate non-response due to advanced age, chronic wasting, and vitamin deficiencies, immunization should ideally be anticipated. Starting vaccination systematically during pre-terminal chronic kidney disease stages 4 and 5 (non-dialyzed) [10] allows the immune system to build optimal antibody responses while uremic toxicity is still limited, ensuring robust protection prior to entering the high-risk dialysis clinical environment.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest is to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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