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Observational Study

Exploration of nucleos(t)ide analogs cessation in chronic hepatitis B patients with hepatitis B e antigen loss

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Abstract

BACKGROUND

Nucleos(t)ide analogs (NAs) cessation in chronic hepatitis B (CHB) patients remains a matter of debate in clinical practice. Current guidelines recommend that patients with hepatitis B e antigen (HBeAg) seroconversion discontinue NAs after relatively long-term consolidation therapy. However, many patients fail to achieve HBeAg seroconversion after the long-term loss of HBeAg, even if hepatitis B surface antigen (HBsAg) loss occurs. It remains unclear whether NAs can be discontinued in this subset of patients.

AIM

To investigate the outcomes and factors associated with HBeAg-positive CHB patients with HBeAg loss (without hepatitis B e antibody) after cessation of NAs.

METHODS

We studied patients who discontinued NAs after achieving HBeAg loss. The Cox proportional hazards model was used to identify predictors for virological relapse after cessation of NAs. The cut-off value of the consolidation period was confirmed using receiver operating characteristic curves; we confirmed the cut-off value of HBsAg according to a previous study. The log-rank test was used to

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compare cumulative relapse rates among groups. We also studied patients with CHB who achieved HBeAg seroconversion and compared their cumulative relapse rates. Propensity score matching analysis (PSM) was used to balance baseline characteristics between the groups.

RESULTS

We included 83 patients with HBeAg loss. The mean age of these patients was 32.1 ± 9.5 years, and the majority was male (67.5%). Thirty-eight patients relapsed, and the cumulative relapse rate at months 3, 6, 12, 24, 36, 60, 120, and 180 were 22.9%, 36.1%, 41.0%, 43.5%, 45.0%, 45.0%, 45.0%, and 52.8%, respectively. Twenty-six (68.4%) patients relapsed in the first 3 mo after NAs cessation, and 35 patients (92.1%) relapsed in the first year after NAs cessation. Consolidation period (≥ 24 mo *vs* < 24 mo) (HR 0.506, $P = 0.043$) and HBsAg at cessation (≥ 100 IU/mL *vs* < 100 IU/mL) (HR 14.869, $P = 0.008$) were significant predictors in multivariate Cox regression. In the PSM cohort, which included 144 patients, there were lower cumulative relapse rates in patients with HBeAg seroconversion ($P = 0.036$).

CONCLUSION

HBeAg-positive CHB patients with HBeAg loss may be able to discontinue NAs therapy after long-term consolidation, especially in patients with HBsAg at cessation < 100 IU/mL. Careful monitoring, especially in the early stages after cessation, may ensure a favorable outcome.

Key Words: Chronic hepatitis B; Hepatitis B e antigen; Nucleos(t)ide analogs; Cessation

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Core Tip: A considerable proportion of patients fail to achieve hepatitis B e antigen (HBeAg) seroconversion after the long-term loss of HBeAg, even if hepatitis B surface antigen loss occurs. It remains unclear whether nucleos(t)ide analogs (NAs) can be discontinued in this subset of patients. The current study included patients who discontinued NAs after achieving HBeAg loss (without hepatitis B e antibody) for long periods since 2001. It was concluded that these patients may be able to discontinue NAs therapy after long-term consolidation. HBsAg at cessation < 100 IU/mL predicts sustained virological response after NAs cessation. Careful monitoring, especially in the early stages after cessation, may ensure a favorable outcome.

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INTRODUCTION

Nucleos(t)ide analogues (NAs) are primary therapeutic agents for hepatitis B virus (HBV) infection; they significantly improved outcomes in patients with chronic hepatitis B (CHB)^[1-3]. However, taking these medicines for life presents a substantial obstacle to compliance among patients with CHB. Therefore, NAs withdrawal is being studied^[4-6].

Hepatitis B e antigen (HBeAg) has been proved to be associated with several immunomodulatory functions in HBeAg-positive patients with CHB, including replication of HBV and responses of the host to the virus^[7,8]. Current guidelines recommend that patients with HBeAg seroconversion discontinue NAs after relatively long-term consolidation therapy^[1-3]. Although only a small number of patients achieved a loss of hepatitis B surface antigen (HBsAg), our previous study showed acceptable cumulative relapse rates for HBeAg-positive patients who achieved HBeAg seroconversion^[5].

A considerable proportion of patients fail to achieve HBeAg seroconversion after

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the long-term loss of HBeAg, even if HBsAg loss occurs^[9,10]. It remains unclear whether NAs can be discontinued in this subset of patients^[1-3,11,12]. In an outcome study of patients with CHB and HBeAg loss after NAs cessation, 17 of 25 patients maintained sustained virological response (SVR)^[10]. Another study also included CHB patients with HBeAg loss and the off-treatment virologic responses remained poor^[13]. However, these studies were not explicitly designed for this subpopulation; furthermore, the sample sizes were small, and the consolidation periods were short^[10,13]. Therefore, the persuasiveness of the conclusions was limited.

Some patients in our previous cohort^[5,14] discontinued NAs after achieving HBeAg loss for long periods because of personal decisions and were not included in our previous analyses, while some maintained SVR. Therefore, the purpose of the present study was to determine the outcomes and related factors in patients with HBeAg-positive CHB with HBeAg loss [without hepatitis B e antibody (HBeAb)] after NAs cessation.

MATERIALS AND METHODS

Patients and methods

Patients: In our previous observational cohort, including CHB patients who discontinued NAs therapy and underwent regular follow-up, some discontinued NAs after achieving HBeAg loss (without HBeAb) for long periods. We included them in the current study (Cohort A). Before the decision to discontinue NAs, we informed all patients of the current guidelines, and we carefully evaluated all patients for potential risks. The patients decided to discontinue NAs according to their values and the state of their illness. We closely monitored them during follow-up after NAs cessation. Cumulative relapse rates were compared between HBeAg-positive patients with CHB who achieved HBeAg seroconversion (Cohort B) and Cohort A. **Figure 1** describes the flowchart of patient inclusion. We recruited all patients from The Second Hospital, Cheeloo College of Medicine, Shandong University, between December 2001 and January 2020. All patients provided written informed consent. The Ethical Committee of The Second Hospital, Cheeloo College of Medicine, Shandong University, approved the study protocol. The study followed the principles of the Helsinki Declaration.

We previously published treatment criteria for NAs^[5]. Cessation criteria required that patients in Cohort A receive at least 6 mo consolidation therapy after achieving HBeAg loss, with undetectable HBV DNA and normal alanine aminotransferase (ALT), and total therapy duration should last at least 18 mo. Patients in Cohort B should receive at least 6 mo consolidation therapy after achieving HBeAg seroconversion, with undetectable HBV DNA and normal ALT, and total therapy duration should be at least 12 mo. As per updated guidelines, consolidation therapy in these groups extended to at least 12 mo.

Exclusion criteria were signs of cirrhosis or decompensated liver disease and NAs resistance.

Data collection

We retrospectively collected pretreatment baseline data. After NAs cessation, the patients were followed-up at months 1, 2, 3, 4, 6, 9, and 12, and every 6 mo thereafter. The follow-up evaluation included liver biochemistry, serology of HBV, and quantification of HBV DNA.

The current study's observational endpoint was virological relapse, which was defined as serum HBV DNA > 10⁴ copies/mL after NAs cessation confirmed 2 wk apart.

Statistical analyses

Variables were expressed as mean ± SD, median [interquartile range (IQR)], or number (percent) and were compared using the *t*-test, Mann-Whitney *U* test, chi-squared test, or Fisher's exact test. Cox proportional hazards model was used to identify predictors for response status after NAs cessation. The cut-off value of the consolidation period was confirmed using receiver operating characteristic curves; we confirmed the cut-off value of HBsAg according to a previous study^[15]. The log-rank test was performed to compare cumulative relapse rates across groups. Propensity score matching (PSM) analysis was used to balance baseline characteristics between patients with HBeAg loss (Cohort A) and HBeAg seroconversion (Cohort B). We used 1:1 nearest-neighbor matching and a match tolerance of 0.10. All statistical analyses were performed using IBM SPSS version 22.0 (IBM Corp., Armonk, NY, United States). The statistical

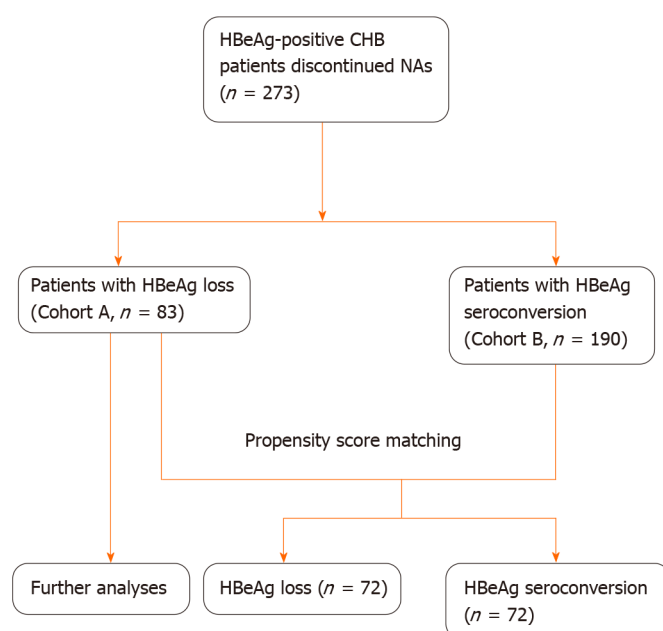


Figure 1 Flowchart of patient inclusion. CHB: Chronic hepatitis B; NAs: Nucleos(t)ide analogs.

procedure was reviewed by a biomedical statistician (Zhang Y).

RESULTS

Characteristics and virological response in patients with HBeAg loss (Cohort A)

There were 83 patients in Cohort A. The mean age of these patients was 32.1 ± 9.5 years, and the majority was male (56 patients, 67.5%). We treated patients for a median of 49 (IQR 36–61) mo. The median follow-up period for patients with SVR was 72 (IQR 36–108) mo. Patients received single NAs, including lamivudine in 45 patients, adefovir dipivoxil in 24 patients, telbivudine in nine patients, entecavir in four patients, and tenofovir in one patient. **Table 1** displays the baseline characteristics of the patients. **Figure 2** describes the distribution of ages and consolidation periods.

Thirty-eight patients relapsed and the cumulative relapse rates at month 3, 6, 12, 24, 36, 60, 120, and 180 were 22.9%, 36.1%, 41.0%, 43.5%, 45.0%, 45.0%, 45.0%, and 52.8%, respectively. Twenty-six (68.4%) patients relapsed in the first 3 mo after NAs cessation, and 35 patients (92.1%) relapsed in the first year after NAs cessation. The latest relapse occurred at month 129 after NAs cessation. **Table 1** displays the baseline characteristics of relapsed patients and patients with SVR. All relapsed patients received close follow-up or salvage treatments according to their condition and treatment history. No liver failure or hepatic decompensation occurred.

Univariate and multivariate Cox regression determined predictors for virological relapse. Only consolidation period (≥ 24 mo *vs* < 24 mo) (HR 0.506, $P = 0.043$) and HBsAg at cessation (≥ 100 IU/mL *vs* < 100 IU/mL) (HR 14.869, $P = 0.008$) were significant predictors in multivariate regression (**Table 2**).

Among the 19 patients with HBsAg at cessation < 100 IU/mL, only one patient relapsed at month 3 after NAs cessation, and the cumulative relapse rates were significantly lower than those of patients with HBsAg at cessation ≥ 100 IU/mL (log-rank test, $P < 0.001$, **Figure 3A**). For the 51 patients with longer consolidation periods (≥ 24 mo), the cumulative relapse rates at month 3, 6, 12, 24, 36, 60, 120, and 180 were 17.6%, 27.5%, 31.4%, 31.4%, 33.8%, 33.8%, 33.8%, and 44.9%, respectively, which maintained significantly lower relapse rates than patients with shorter consolidation periods (< 24 mo) (log-rank test, $P = 0.012$, **Figure 3B**).

Patients with functional cure in Cohort A

Six of 83 patients achieved functional cure (HBsAg loss) at cessation. All these patients maintained SVR and HBsAg loss during follow-up. The other 11 patients, although they had detectable HBsAg at cessation, also achieved HBsAg loss during follow-up.

Table 1 Clinical characteristics of the included patients

	Total (n = 83)	Relapser (n = 38)	Non-relapser (n = 45)	P values ²
Age at cessation (yr)	32.1 ± 9.5	33.5 ± 9.8	31.0 ± 9.3	0.232
Male, n (%)	56 (67.5)	24 (63.2)	32 (71.1)	0.441
HBsAg < 100 IU/mL, n (%)	19 (22.9)	1 (2.6)	18 (40.0)	< 0.001
Pretreatment HBV DNA (log10 copies/mL) ¹	7.17 (6.71-7.68)	7.29 (6.93-7.69)	7.00 (6.10-7.68)	0.123
Total treatment period (mo) ¹	49 (36-61)	50 (36-63)	49 (37-61)	0.876
Pretreatment ALT ¹	151 (115-287)	149 (118-256)	163 (112-305)	0.721
Pretreatment AST ¹	103 (68-180)	105 (69-181)	102 (68-169)	0.927
HBV DNA negativity last time (mo) ¹	44 (33-58)	44 (33-60)	44 (34-57)	0.964
Time to HBeAg loss (mo) ¹	14 (6-31)	19 (9-33)	12 (6-30)	0.241
Consolidation periods (mo) ¹	28 (19-40)	23 (18-38)	30 (21-40)	0.102

¹median (IQR).²t test, Mann-Whitney U test or χ^2 test. HBeAg: Hepatitis B e antigen; HBV: Hepatitis B virus; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; HBsAg: Hepatitis B surface antigen.**Table 2 Determination of factors related to virological relapse in patients with hepatitis B e antigen loss**

	Univariate			Multivariate		
	HR	95%CI	P values	HR	95%CI	P values
Age at cessation	1.021	0.987-1.056	0.235			
Gender	0.783	0.405-1.515	0.468			
Pretreatment ALT	0.999	0.998-1.001	0.451			
Pretreatment AST	1.000	0.997-1.002	0.716			
Pretreatment HBV DNA (log10 copies/mL)	1.391	0.942-2.054	0.097	1.256	0.816-1.933	0.300
Total treatment duration	1.001	0.989-1.013	0.826			
HBV DNA negativity last time	1.001	0.988-1.013	0.915			
Consolidation periods (≥ 24 mo vs < 24 mo)	0.469	0.247-0.891	0.021	0.506	0.262-0.978	0.043
HBsAg at cessation (≥ 100 IU/mL vs < 100 IU/mL)	15.515	2.119-113.575	0.007	14.869	2.027-109.084	0.008

HR: Hazard ratio; HBeAg: Hepatitis B e antigen; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; HBV: Hepatitis B virus; HBsAg: Hepatitis B surface antigen.

after cessation and maintained SVR. The median follow-up period of these 11 patients was 108 (IQR 78–180) mo.

Comparison of cumulative relapse rates between CHB patients with HBeAg loss (Cohort A) and HBeAg seroconversion (Cohort B)

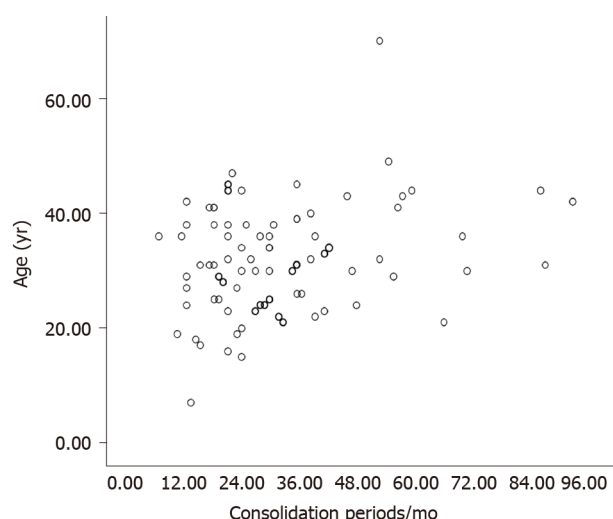
We preliminarily screened 83 patients in Cohort A and 190 patients in Cohort B for PSM. We included 144 patients (72 pairs) in the PSM cohort (Figure 1). The baseline characteristics remained comparable between the two groups (Table 3). The log-rank test revealed lower cumulative relapse rates in patients with HBeAg seroconversion ($P = 0.036$, Figure 4).

DISCUSSION

The response status of patients with HBeAg-positive CHB with HBeAg loss after NAs cessation was evaluated. Despite the absence of HBeAb, these patients maintained

Table 3 Comparison of baseline clinical characteristics in the propensity score matching cohort

	HBeAg loss (<i>n</i> = 72)	HBeAg seroconversion (<i>n</i> = 72)	<i>P</i> values ²
Age at cessation (yr)	31.8 ± 10.0	31.5 ± 11.8	0.873
Male, <i>n</i> (%)	49 (68.1)	48 (66.7)	0.859
Functional cure, <i>n</i> (%)	15 (20.8)	8 (11.1)	0.111
Pretreatment HBV DNA (log10 copies/mL) ¹	7.14 (6.70-7.65)	7.00 (6.67-7.67)	0.781
Pretreatment ALT ¹	151 (114-287)	200 (117-301)	0.394
Pretreatment AST ¹	102 (69 -188)	122 (72 -204)	0.327
Consolidation periods (mo) ¹	28 (21-40)	23 (15-37)	0.065
Time to HBeAg loss/conversion ¹	12 (6-25)	15 (7-27)	0.566

¹median (IQR).²*t* test, Mann-Whitney *U* test or χ^2 test. HBeAg: Hepatitis B e antigen; HBV: Hepatitis B virus; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase.**Figure 2 Distribution of age and consolidation periods of patients with hepatitis B e antigen loss.**

acceptable virological response after relatively long-term consolidation therapy, especially in patients with HBsAg at cessation < 100 IU/mL. After PSM, the cumulative relapse rates were higher than those in patients with HBeAg seroconversion. More extended consolidation periods (≥ 24 mo) and low HBsAg at cessation (< 100 IU/mL) predicted better response after NAs cessation.

NAs cessation remains a matter of debate in clinical practice. Although a functional cure has been recognized as a feasible goal and an acknowledged treatment endpoint of NAs therapy^[12,16,17], the low incidence rates are an essential obstacle to its clinical application. Furthermore, a considerable proportion of HBeAg-positive patients with CHB stopped NAs before achieving HBsAg loss; nevertheless, the response status remained acceptable^[5,14]. For these reasons, NAs cessation following HBeAg seroconversion plus more than 1–3-year consolidation therapy is recommended by current guidelines for HBeAg-positive patients with CHB^[1-3]. Because some patients in our cohort discontinued NAs after achieving HBeAg loss (without HBeAb) for long periods, the current study compared cumulative relapse rates between CHB patients with HBeAg loss and those with HBeAg seroconversion. Although the cumulative relapse rates remained acceptable in patients with HBeAg loss (45.0% at year 10), better outcomes were observed in patients with HBeAg seroconversion.

To achieve better outcomes for CHB patients with HBeAg loss, we recommend sufficient consolidation periods. In the present study, the consolidation period (≥ 24 mo) was considered an independent predictor for SVR. There were similar conclusions in previous studies exploring factors predicting drug withdrawal for patients with

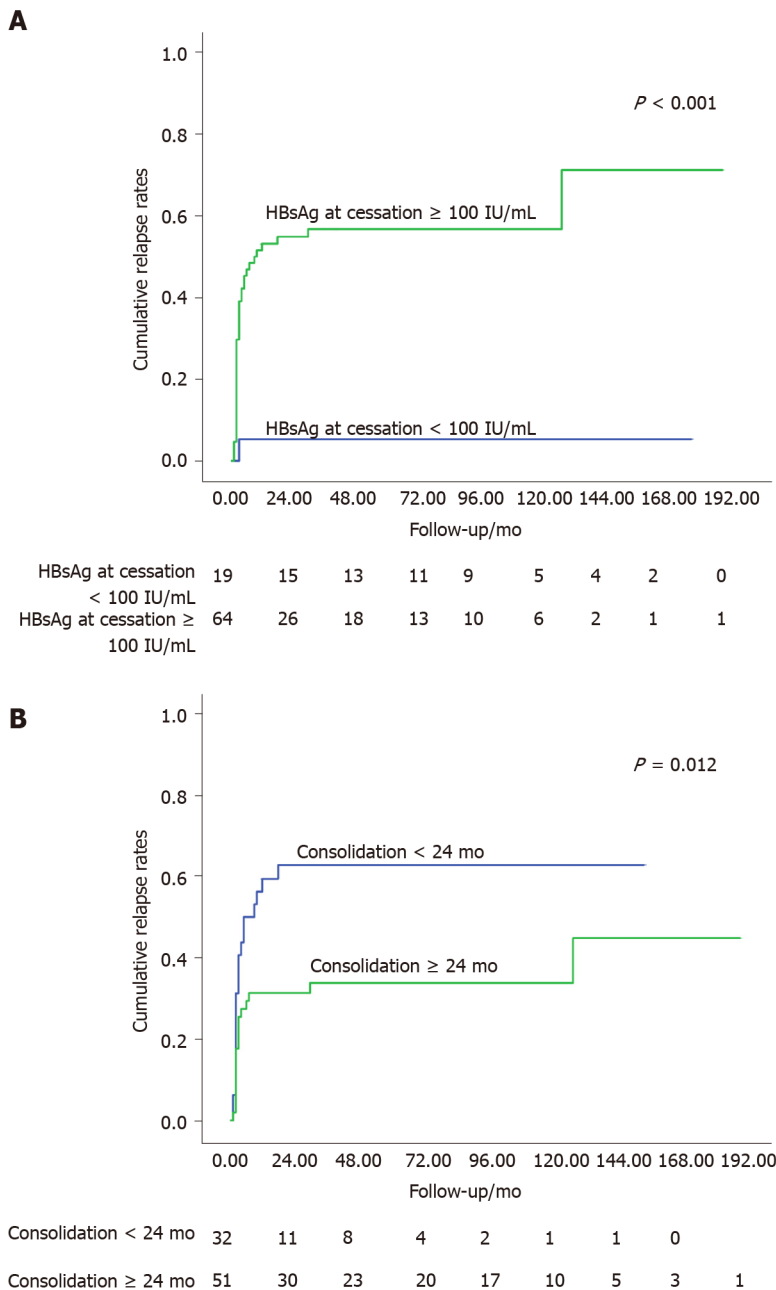


Figure 3 Cumulative virological relapse rates. Cumulative virological relapse rates in A: Hepatitis B e antigen (HBeAg) loss patients with hepatitis B surface antigen at cessation ≥ 100 IU/mL and < 100 IU/mL; B: HBeAg loss patients with consolidation periods ≥ 24 mo and < 24 mo. HBsAg: Hepatitis B surface antigen.

CHB achieving HBeAg seroconversion^[5,10,18-21]. Nevertheless, the consolidation periods remain controversial. The three cut-off values (12 mo, 18 mo, and 36 mo) adopted by different cohorts might be attributed to various sample size distributions in different consolidation periods. In the current study, more than one-third of patients received consolidation for more than 36 mo (Figure 2), which ensured the cut-off value's credibility (≥ 24 mo). In addition, according to recommendations of early guidelines, three patients in Cohort A discontinued NAs with consolidation periods less than 12 mo. All these patients relapsed and were re-treated with good outcomes.

In addition to lengthier consolidation, several other factors in Cohort A patients may help obtain better outcomes. As mentioned above, HBsAg is an essential predictor of response status after NAs cessation^[15]. Lower HBsAg at cessation predicted better outcomes^[15], and our present results corroborate this finding. In Cohort A, seventeen patients achieved HBsAg loss (six patients at cessation and another 11 patients during follow-up) in the present study, a relatively high percentage (20.5%). All these patients maintained HBsAg loss and SVR during follow-up. Second, younger age predicted SVR in both HBeAg-positive and HBeAg-negative

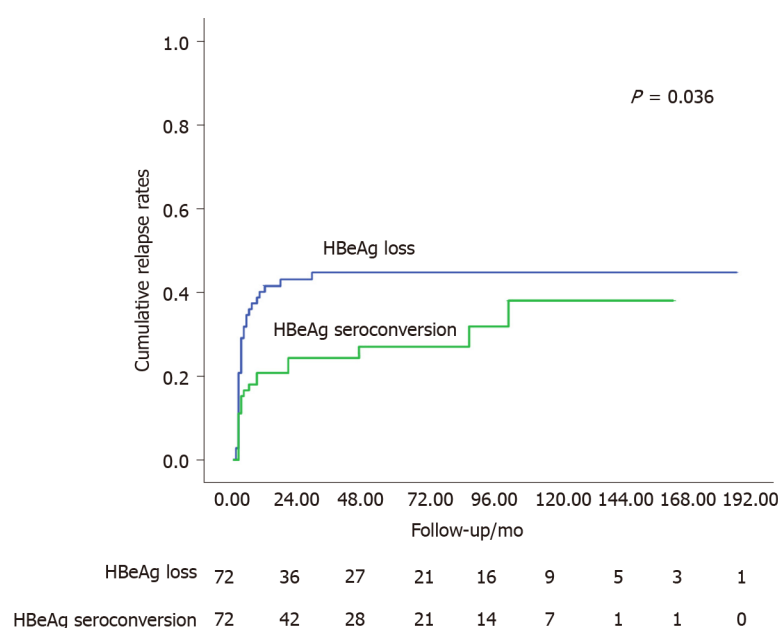


Figure 4 Cumulative virological relapse rates in patients with hepatitis B e antigen loss and seroconversion. HBeAg: Hepatitis B e antigen.

CHB patients^[5,10,13,22,23]. However, age was not a predictor in the current study. The mean age of the patients in Cohort A was 32.1 ± 9.5 years, a relatively young sample. Furthermore, 82 patients (98.8%) were under 50 years old, while 65 patients (78.3%) were under 40 years old (Figure 2). The narrow age spectrum may also conceal the role of age in prognosis after cessation. Third, we excluded patients with cirrhosis and decompensated liver disease. The current guidelines recommend indefinite antiviral therapy for these patients^[1-3]. We also excluded patients with NAs resistance to obtain better outcomes.

We followed patients in the current study regularly to identify relapse as early as possible. Most patients (92.1%) relapsed in the first year after NAs cessation, especially during the first 3 mo (68.4%), suggesting that more careful monitoring is critical in the early stages after cessation. These characteristics were similar to those in patients achieving HBeAg seroconversion^[5,14].

There are some limitations to the current study. First, most patients did not receive first-line NAs because of their enrollment in a relatively early period (since 2001), and we followed them for relatively long periods. We excluded patients with NAs resistance to minimize the influence of low-genetic barrier NAs. Second, as an exploratory study, some features of the included patients made them more likely to achieve a sustained response, which might decrease the representativeness of the current study.

CONCLUSION

In conclusion, HBeAg-positive CHB patients with HBeAg loss may be able to discontinue NAs therapy after long-term consolidation. HBsAg at cessation < 100 IU/mL predicts SVR after NAs cessation. Careful monitoring, especially in the early stages after cessation, should be adopted to ensure favorable outcomes.

ARTICLE HIGHLIGHTS

Research background

Nucleos(t)ide analogs (NAs) cessation in chronic hepatitis B (CHB) patients remains a matter of debate in clinical practice, especially in patients who fail to achieve hepatitis B e antigen (HBeAg) seroconversion after the long-term loss of HBeAg. Few studies were explicitly designed for this subpopulation.

Research motivation

To determine whether chronic hepatitis B patients with HBeAg loss could discontinue NAs after long-term consolidation.

Research objectives

We investigated the outcomes and factors associated with HBeAg-positive CHB patients with HBeAg loss [without hepatitis B e antibody (HBeAb)] after cessation of NAs.

Research methods

Patients who discontinued NAs after achieving HBeAg loss (without HBeAb) for long periods were included and predictive factors were explored. CHB patients who achieved HBeAg seroconversion were also included for controls.

Research results

HBeAg-positive CHB patients with HBeAg loss maintained acceptable virological response after NAs cessation, especially in patients with hepatitis B surface antigen (HBsAg) at cessation < 100 IU/mL. After PSM, the cumulative relapse rates were higher than those in patients with HBeAg seroconversion. More extended consolidation periods (≥ 24 mo) and low HBsAg at cessation (< 100 IU/mL) predicted better response after NAs cessation.

Research conclusions

HBeAg-positive CHB patients with HBeAg loss may be able to discontinue NAs therapy after long-term consolidation, especially in patients with HBsAg at cessation < 100 IU/mL.

Research perspectives

HBeAg-positive CHB patients with HBeAg loss may be able to discontinue NAs therapy after long-term consolidation and lower HBsAg at cessation is preferred. Careful monitoring, especially in the early stages after cessation, may ensure a favorable outcome.

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