Assessment of HBV flare in a randomized clinical trial in HIV/HBV coinfected subjects initiating HBV-active antiretroviral therapy in Thailand

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Abstract

Background: Hepatic Flare (HF) after initiation of highly active antiretroviral therapy (HAART) in HIV-HBV coinfected individuals is well recognized but prospective data on predictors and subsequent outcome are limited.

Methods: The Tenofovir in HIV-HBV coinfection study was a randomized clinical trial of HBV-active HAART including lamivudine and/or tenofovir in antiretroviral naïve HIV-HBV individuals in Thailand.

Results: Early HF (EHF) was defined as ALT > 5 × ULN during the first 12 weeks. EHF was observed in 8 (22%) of individuals at a median of 56 days. 6/8 EHF cases were asymptomatic and resolved with HAART continuation, however one subject with underlying cirrhosis died following rapid hepatic decompensation. EHF was significantly associated with higher baseline ALT (79 IU/L vs 36 IU/L non-EHF, \( p = 0.008 \)) and HBV DNA (9.9 log10 c/ml vs 8.4 log10 c/ml non EHF, \( p = 0.009 \)), and subsequent serological change. HBeAg loss occurred in 75% of EHF cases versus 22% in non-EHF (\( p = 0.04 \)), and HBsAg loss in 25% of EHF cases versus 4% of non-EHF (\( p = 0.053 \)).

Conclusion: EHF after HBV active HAART initiation was frequently observed in this population. Timing of EHF, association with elevated ALT and HBV DNA and high rate of seroconversion are all consistent with immune restoration as the likely underlying process.

Clinical Trial number: NCT00192595.

Keywords: Hepatitis B, HIV, Antiretroviral therapy, Asia, Hepatic flare, Hepatotoxicity

Background

Hepatotoxicity (HT) after HAART initiation has been reported in 2-14% of HIV positive individuals [1-3], and the risk increases significantly in HBV or HCV coinfected individuals [1,4]. Definitions of HT vary but the most commonly used is based on the AIDS Clinical Trial Group (ACTG) criteria in which an increase in ALT and/or AST above 5 × upper limit of normal (ULN) (Grade 3) is defined as severe HT. HF (HF) appears to be particularly common within the first months after HAART initiation, suggesting a potential immunological component to its development. The outcome following HF may be beneficial with subsequent serological change; on the other it may also be associated with morbidity, and even mortality. Although, HF after initiation of HAART in HIV-HBV coinfected individuals is well recognized, prospective data on predictors and subsequent outcome are limited.

We therefore examined the incidence, characteristics, predictors and subsequent outcome of HF occurring in the first 12 weeks after HAART initiation (early HF [EHF]) within the Tenofovir in Coinfection study (TICO), a randomized clinical trial of HBV-active HAART including lamivudine and/or tenofovir in 36 antiretroviral (ARV) naïve HIV-HBV individuals in Thailand.
Methods
Full eligibility criteria for this study are given elsewhere [5], but in brief, subjects were HIV-1 antibody positive and naïve to ARV with chronic hepatitis B infection (HBV surface antigen (HBsAg)-positive > 6 months apart with HBV DNA > 100,000 copies/mL). Subjects were excluded if they had evidence of other causes for chronic liver disease ie hepatitis C virus, acute hepatitis A virus, autoimmune disease, serum ALT level > 1000 IU/L. Early HF was defined as ALT > 5 × ULN during the first 12 weeks.

Liver function tests (LFTs) were routinely performed at weeks 0, 4, 8, 12, 24, 36 and 48. Plasma for HBV DNA testing and peripheral blood mononuclear cells (PBMC) were collected at weeks 0, 4, 8, 12, 24 and 48 and stored at -80°C and -140°C respectively. HBV DNA levels were analysed at the Victorian Infectious Diseases Laboratory (VIDRL), Melbourne, Australia. HBV DNA measurement was performed by the Versant HBV DNA 3.0 bDNA assay (Siemens HealthCare, Tarrytown, NY, USA). The linear dynamic range of the assay was from 2 × 10^3 - 1 × 10^8 copies/mL.

Table 1 Univariate analysis of predictors of early hepatic flare.

| Predictor                        | EHF   | Non-EHF | p-value  |
|----------------------------------|-------|---------|----------|
| Age yrs (median, IQR)            | 37 (33-42) | 33 (28-40) | 0.25     |
| Male gender                      | 88%   | 43%     | 0.12     |
| HBeAg positive                   | 50%   | 64%     | 0.47     |
| Alcohol (> 3 units/day)          | 25%   | 25%     | 1.00     |
| Cirrhosis                        | 20%   | 42%     | 0.36     |
| HBV Genotype C                   | 75%   | 82%     | 0.28     |
| BMI kg/m² (median, IQR)          | 19 (18-20) | 20 (18-22) | 0.20     |
| BL CD4 cells/mm³ (median, IQR)   | 52 (18-131) | 32 (19-214) | 0.96     |
| BL HIV RNA log_{10} c/ml (median, IQR) | 4.9 (4.7-5.1) | 4.7 (4.3-5.1) | 0.22     |
| BL ALT IU/L (median, IQR)        | 79 (59-96) | 36 (22-59) | 0.008*   |
| BL HBV DNA log_{10} c/ml (median, IQR) | 9.9 (8.4-10.4) | 8.4 (7.8-9.0) | 0.009*   |
| Randomised HBV therapy           |       |         |          |
| 3TC n = 5                        |       | 3TC n = 8 | 0.193    |
| TDF n = 2                        |       | TDF n = 10 | 1.00     |
| 3TC/TDF n = 1                    |       | 3TC/TDF n = 10 | 1.00     |
| OI prophylaxis (artonazole and/or cotrimoxazole) | 88% | 61% | 0.162 |
| Isoniazid therapy                | 0%    | 21%     | 0.302    |

*Statistically significant at p < 0.05

All comparisons made using the Mann-Whitney U-test except categorical variables where Chi-squared or Fisher’s Exact test used.
There were no differences between the two groups for age, gender, HBV genotype, HIV related parameters (CD4 count and HIV RNA) or use of potentially hepatotoxic agents (isoniazid/rifampicin/fluconazole/cotrimoxazole/alcohol) prior to HAART initiation. Similarly no significant differences were observed by randomised therapy, although EHF was seen in 38% of subjects in the arm containing 3TC alone versus 15% of subjects on TDF-containing regimens ($p = 0.078$).

ALT and HBV DNA remained significantly higher in the EHF group throughout the first 12 weeks of therapy (Figure 1) although by week 12 the difference in HBV DNA between groups had become non-significant ($4.31 \text{log}_{10} \text{c/ml vs 3.88 \text{log}_{10} \text{c/ml}}, p = 0.96$). The reduction in HBV DNA between weeks 0 and 12 was significantly greater in the subjects who experienced HF than those that did not ($p = 0.039$). ALT remained significantly higher in the EHF group at week 12 of therapy (median 153 IU/L vs 36 IU/L, $p = 0.03$) but was similar to the non-EHF group by wk 24 (median 31 IU/L vs 43 IU/L, $p = 0.26$) and all time points thereafter.

EHF was associated with subsequent HBeAg serological change. HBeAg loss occurred in 75% of EHF cases versus 22% in non-EHF ($p = 0.04$), and HBsAg loss in 25% of EHF cases versus 4% of non-EHF ($p = 0.053$). In fact, the case of HBsAg loss in the non-EHF group was a subject who experienced a late HF with an ALT rise to 254 IU/L at week 24 having previously been normal. Follow-up serological testing demonstrated anti-HBe seroconversion and HBsAg loss in this subject. This was the only other subject in the study to experience HF after HAART initiation, giving an overall rate of HF of 25% over 48 weeks. Both HBeAg and HBsAg loss were significantly predicted by the occurrence of any HF. Among HBeAg positive subjects, 80% of cases with HF at any time point experienced HBeAg loss compared with 18% in those without HF ($p = 0.009$), and among all subjects 33% of HF cases experienced HBsAg loss compared to 0% in subjects without any HF ($p = 0.002$).

**Discussion**

EHF after HBV active HAART initiation was frequently observed in this population. We found that elevated ALT and higher HBV DNA at baseline are significant predictors of EHF. In addition the occurrence of EHF was positively associated with subsequent HBeAg and HBsAg loss, both of which occurred at elevated rates (33% and 8% respectively) during the 48-week study follow-up.

Elevated transaminases in the setting of HAART and viral hepatitis co-infection are commonly multifactorial and may reflect natural alterations in hepatitis disease activity, direct antiretroviral hepatotoxicity, drug hypersensitivity, co-existent hepatotoxic medication, alcohol excess and immune restoration disease. The reasons for
the high rate of flare observed in our prospective clinical trial are unclear but can be hypothesized.

Our population had advanced immunodeficiency with a median pre-HAART CD4 count of only 36 cells/mm³ and high usage of potentially hepatotoxic medications including cotrimoxazole, fluconazole and isoniazid/rifampicin - however none of these factors were identified as associated with EHF in univariate analysis. Similarly, no difference was observed in baseline level of alcohol use between groups (Table 1). Nucleoside analogue agents are also potentially hepatotoxic, but usually through the development of mitochondrial dysfunction and microvesicular hepatic steatosis - this was felt to be unlikely in our subjects given the time frame in which the HF events were observed and the absence of associated features such as lactic acidosis suggesting mitochondrial dysfunction. All subjects were prescribed EFV and EFV associated hepatotoxicity has been clearly described, although at a lesser rate than with nevirapine [4,6]. EFV induced hepatotoxicity as a cause of HF is possible in the symptomatic case, (although subsequent EFV reintroduction without HF at a later date makes this unlikely); and the possibility of EFV-induced hepatotoxicity as a cause of death in the case with cirrhosis is also conceivable.

Overall however, timing of EHF, association with elevated ALT and HBV DNA and high rate of seroconversion are all consistent with immune restoration stimulating HBV-specific immune responses as the likely underlying process.

Spontaneous flares in CHB are well recognised and reflect the dynamic nature of the balance between immunological control and HBV replication [7]. Sometimes, but not universally, these flares will be followed by HBeAg loss, anti-HBe seroconversion and even occasionally HBsAg loss/seroconversion. In the context of HBV treatment and effective HBV DNA reduction the rate of HF increases, particularly in the early months of treatment [8,9]. These flares likely reflect an underlying shift in host-viral balance with some regeneration of host T-cell responsiveness as HBV DNA decreases [10], but are still accompanied by anti-HBe seroconversion in around only 20% of subjects by 1 year [8].

In the setting of HIV co-infection the situation is enhanced by the simultaneous reduction in HIV RNA observed with effective HAART and the subsequent restoration of either an adaptive or innate response to HBV antigens. The concept of immune restoration disease (IRD) is characterised by the finding of rapid restoration in immunity in the presence of a high pathogen load resulting in abnormal and exaggerated immune responses, often mediated by high levels of interferon gamma [11-13]. Besides elevated ALT, our study identified higher HBV viral load both at baseline and throughout the early weeks of therapy, as a significant predictor of EHF, a finding consistent with the theory of IRD and high antigen burden as a cause for flare in these subjects. This theory is supported by our findings of elevated CXCL10, an interferon stimulated gene, in patients with EHF within this study [14].

The most striking aspect of our study however is the link between HF and the high rate of subsequent seroconversion. In a retrospective study examining the role of 3TC-containing HAART on serological change in 82 HIV-HBV coinfected subjects, Mailhes et al reported an anti-HBe seroconversion rate of 17% and an overall HBsAg loss rate of 6% during a median follow-up of 5 years [15]. Interestingly, they found more advanced HIV CDC stage at baseline to be associated with subsequent seroconversion rates. HBsAg and/or HBeAg seroconversion occurred in 29% of stage C subjects versus only 3% of patients with stage A disease, again suggesting a major role for immunorestitution in promoting seroconversion. One specific difference in our study to the majority of reports on outcomes in HIV-HBV coinfected individuals commencing HAART is that our population was Asian with predominantly Genotype C and likely vertically acquired HBV disease. Thus differences in the virus, host and/or natural history of HBV in this population may all be contributing to our findings. Given the overwhelming greater burden of HBV disease in Asian countries, further study of the mechanisms and outcomes of HBV-active HAART in this population are certainly required.

Our study is undoubtedly limited by the relatively small number of subjects to elucidate further any additional associations or conclusions. However, it is one of the few randomised clinical trials performed in this population.

**Conclusion**

The rate of HF is high during the first 12 weeks of HBV-active HAART initiation in an advanced immunodeficient Asian population. Although the mechanisms underlying this may be multifactorial, our findings most strongly support a significant role for HBV immune restoration disease as the major contributing factor. A strategy of short-course lead-in anti-HBV therapy (using drugs without anti-HIV activity) could be studied as a potential mechanism to decrease HBV burden and prevent HF after HAART initiation in such individuals.

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Authors’ contributions
All authors participated in the design of the study. AA and GVM drafted the manuscript. JS, SC and SL performed the laboratory tests. SRL, PM, DAC, GJD and KR reviewed the paper. All authors have seen and approved the final manuscript.

Competing interests
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