**Drug-Induced Hemolytic Crisis During Ibrutinib plus Venetoclax for the Treatment of Mantle-Cell Lymphoma: A Rare Hematologic Adverse Reaction**

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Running title: Ibrutinib plus Venetoclax induced AIHA

**Abstract**

With increasing development of novel targeted agents, several subtypes of lymphoma are stepping into the chemotherapy-free era. Combination of Bruton’s tyrosine kinase (BTK) inhibitor ibrutinib and BCL-2 inhibitor venetoclax has been proven to be highly effective in the treatment of relapsed/refractory mantle cell lymphoma (MCL). The most common adverse events of this combined therapy are gastrointestinal, such as diarrhea, nausea or vomiting, and gastroesophageal reflux. However, hemolysis is a rare event. In this paper, we report a case of a 50-year-old MCL patient who experienced hemolytic crisis during treatment with ibrutinib and venetoclax. The case demonstrates a rare but potentially lethal adverse event and emphasizes the need for suspicion of such an adverse reaction during this combination therapy.

**Key words**: mantle cell lymphoma, hemolytic crisis, ibrutinib, venetoclax

**Introduction**

Mantle cell lymphoma (MCL) is an uncommon subtype of non-Hodgkin lymphoma (NHL) prevalently relating to extranodal sites. Though comprises only 6% of NHL, MCL is a challenge according to its aggressive clinical behavior and poor outcomes [1]. Ibrutinib is a first-in-class covalent and irreversible Bruton’s tyrosine kinase (BTK) inhibitor that has demonstrated activity in several B-cell malignancies [2]. Venetoclax is a highly selective inhibitor of BCL-2, an antiapoptotic protein that has elevated expression in many hematologic malignancies, including MCL [3, 4]. The targeting of BTK and BCL-2 with ibrutinib and venetoclax is the most effective drug approach in the treatment of chronic lymphocytic leukemia (CLL) and relapsed/refractory MCL[5, 6]. The combined therapy of ibrutinib and venetoclax is an innovative strategy and consistent with favorable therapeutic effectiveness in relapsed/refractory MCL patients who have a poor prognosis with current treatment. The most common adverse events of this combined therapy are gastrointestinal, such as diarrhea, nausea or vomiting, and gastroesophageal reflux. Tumor lysis syndrome is a common serious adverse event [5].

**Case report**

# A 50-year-old male patient was diagnosed with MCL (stage IV, simplified MIPI score=3) in 2011, and the first line therapy was 6 cycles of R-hyperCVAD/R-MA, the complete response (CR) duration of which lasted 24 months. In 2013, his disease relapsed and was treated with rituximab+bortezomib+high-dose cytarabine for 3 cycles as the second line therapy. Though CR was attained, the collection of autologous stem cells failed, and thalidomide maintenance was initiated until the disease relapsed later in 2015, and the second progression free survival (PFS) was 32 months. Then, 2 cycles of R-CHOP/R-DHAP were given followed by lenalidomide maintenance, and the disease relapsed the third time in 2017 (PFS = 26 months). The patient developed pancytopenia and high tumor burden at this time, and ibrutinib monotherapy was administrated at the dose of 560 mg per day. Two months later, CR was confirmed by both PET-CT scan and bone marrow biopsy, but the disease relapsed 7 months later in 2018 with significant bone marrow infiltration. Next generation sequencing using a bone marrow specimen did not reveal any mutations involving BTK, CARD11, CD79b, MYD88, or TP53. Venetoclax was given according to the dosing schedule that started at 100 mg per day and increased by 100 mg daily，finally to 600 mg per day. Partial remission (PR) was attained 2 months later, however, venetoclax was discontinued due to the patient's economic status, and the disease progressed 5 months later (PFS = 7 months). After treatment with ibrutinib or venetoclax, we monitored the Coombs’ test periodically, and results of direct antiglobulin test (DAT) showed negative anti-immunoglobulin G (IgG) and anti- complement C3 (C3).

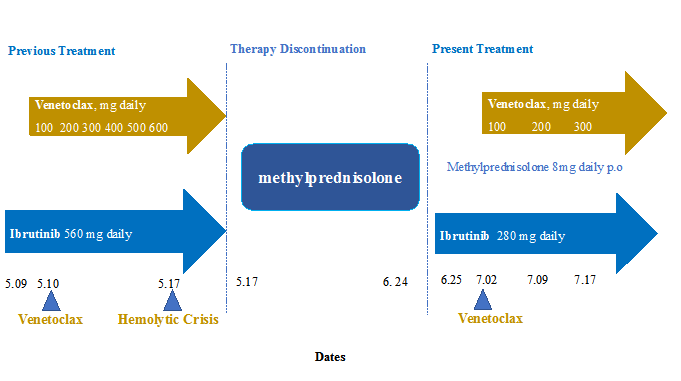
In May 2019, the patient suffered from aggressive progression of MCL, and the PET-CT scan revealed multi-lymphoadenopthy and splenomegaly. As is shown in Figure 1, the patient began with ibrutinib at 560 mg per day orally, and venetoclax was introduced next day according to a dosage schedule that started at 100 mg per day and gradually increased by 100 mg daily, and finally to 600 mg per day. After 2 days of this full-dose combination of ibrutinib and venetoclax, the patient presented to our clinic with dizziness, severe fatigue, pallor, and soy-sauce colored urine. Laboratory test results showed an extremely low level of hemoglobin (28.0 g/L) and significant increase of reticulocyte count (19.5%), total bilirubin (TBIL 3.567 mg/dL), and indirect bilirubin (3.029 mg/dL). A Coombs’ test was positive for both anti-IgG and anti-C3, indicating the diagnosis of severe autoimmune hemolytic anemia (AIHA). The hemolytic crisis was considered to be caused by the high-dose combination of ibrutinib plus venetoclax and most likely rapid titration of venetoclax. The probability of an adverse drug reaction (ADR) was assessed using the Naranjo algorithm (see Table 1) [7]. It revealed a probable ADR for a score of +6.

# Table 1. Naranjo scale for likelihood of ibrutinib plus venetoclax induced AIHA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Question | Yes | No | Don’t know | Score |
| 1. Are there previous conclusive reports on this reaction? | +1 | 0 | 0 | 0 |
| 2. Did the adverse event appear after the suspected drug was administered? | +2 | -1 | 0 | +2 |
| 3. Did the adverse reaction improve when the drug was discontinued or a specific antagonist was administered? | +1 | 0 | 0 | +1 |
| 4. Did the adverse reaction reappear when the drug was re-administered? | +2 | -1 | 0 | 0 |
| 5. Are there possible alternative causes that could have caused the reaction? Are there alternate causes (other than the drug) that could have solely caused the reaction? | -1 | +2 | 0 | +2 |
| 6. Did the reaction reappear when a placebo was given? | -1 | +1 | 0 | 0 |
| 7. Was the drug detected in the blood (or other fluids) in concentrations known to be toxic? | +1 | 0 | 0 | 0 |
| 8. Was the reaction more severe when the dose was increased or less severe when the dose was decreased? | +1 | 0 | 0 | +1 |
| 9. Did the patient have a similar reaction to the same or similar drugs in any previous exposure? | +1 | 0 | 0 | 0 |
| 10. Was the adverse event confirmed by any objective evidence? | +1 | 0 | 0 | 0 |
| Total score |  |  |  | 6 |

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# Therefore, this combined therapy was immediately discontinued, and intravenous infusion of methylprednisolone (1000 mg daily for 3 days), immunoglobulin (IVIg) at 25 g for 5 days, as well as washed red blood cells were given. Afterward, the dose of methylprednisolone was halved and maintained for 3 days, and then 250 mg for 4 days. Thereafter, the methylprednisolone was reduced to 80 mg for 4 days and followed by 40 mg for 3 days. Oral administration of 32 mg once daily for 3 days was then administered and stepped down to 8 mg weekly until a maintained dose of 8 mg by mouth once. The adverse event of hemolytic anemia was alleviated with all parameters including hemoglobulin, reticulocyte count, and bilirubin returning to normal level. One month after the onset of hemolytic crisis, anti-MCL treatment was reinitiated for this patient while still taking methylprednisolone 8 mg orally daily. At this time, ibrutinib monotherapy at a dose of 280 mg per day was given for the first week, then venetoclax was administrated 100 mg per day in the second week and increased weekly by 100 mg per day. At the time of writing this manuscript, the patient is receiving 280 mg/d ibrutinib and 300 mg/d venetoclax and is not experiencing any adverse reactions like AIHA.

**Figure 1**. The treatment process of MCL and hemolytic crisis

**Discussion**

This is the first report of a severe AIHA secondary to the combination therapy of ibrutinib and venetoclax in MCL. AIHA is known to complicate CLL and occurs in up to 30% of patients, which is uncommon in patients with aggressive non-Hodgkin's lymphoma, with an estimated incidence of 1% [8]. Drug-induced immune hemolytic anemia can be classified into autoimmune type, drug adsorption type and neoantigen type [9]. Depending on the number of reports in the literature, drugs that most associate to AIHA are the new generation of cephalosporins, diclofenac, oxaliplatin and fludarabin [10]. High dose glucocorticoids are considered the first-line treatment for AIHA. If AIHA is a potential complication of MCL, patients should be more successfully treated by focusing on the underlying lymphoma instead of relying on steroids [11]. In this case, both ibrutinib and venetoclax were discontinued immediately at the onset of AIHA, while a high dose of glucocorticoid was initiated to control AIHA in time. Thus, it can be inferred that AIHA was induced by targeted therapy of ibrutinib and venetoclax, rather than a complication of underlying MCL. Molica and Polliack [12] believed that ibrutinib could be effective in a variety of immune disorders, and also suggested that the acute AIHA appeared in the CLL treatment with ibrutinib was caused by CLL activity rather than an ibrutinib-induced reaction. Although preclinical study indicates that ibrutinib may inhibit production of autoantibodies [13] a detailed mechanism of action of ibrutinib in AIHA needs to be further investigated. AIHA has been reported as one of the adverse events in relapsed/refractory CLL patients treated with venetoclax [14], but it is rarely reported in patients with MCL.

In this case, we consider that the high-dose combination therapy and rapid titration process of venetoclax may contribute to the development of severe AIHA. In the study conducted by Tam C.S *et al* [5], to reduce the risk of the tumor lysis syndrome, patients of MCL took 560 mg ibrutinib daily first. After 4 weeks, venetoclax was added in step-wise, each week increasing 100mg per day up to the maximum dose of 400 mg daily. AIHA was not reported in this study.

**Conclusion**

Since ibrutinib and venetoclax are prescribed with increasing frequency for various types of hematologic malignancies, physicians should be aware of this rare but serious complication.

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**Conflict of Interest:** The authors declare that they have no conflict of interest.

**Ethical approval:** This article does not contain any studies with human participants performed by any of the authors.

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

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