**Name of journal:** ***World Journal of Clinical Cases***

**Manuscript NO: 45692**

**Manuscript type: Case Report**

**Coexistence of breakpoint cluster region-Abelson1 rearrangement and Janus kinase 2 V617F mutation in chronic myeloid leukemia: A case report**

Shi XB *et al*.*BCR-ABL1* and *JAK2 V617F* in CML

**Xue-Bing Shi, Ji-Fa Jiang, Feng-Xiang Jin, Wei Cheng**

**Xue-Bing Shi, Ji-Fa Jiang, Feng-Xiang Jin, Wei Cheng,** Department of Hematology and Oncology, Tongling People’s Hospital, Tongling 244000, Anhui Province, China

**ORCID number:** Xue-Bing Shi (0000-0003-1869-7371); Ji-Fa Jiang (0000-0003-1317-7625); Feng-Xiang Jin (0000-0002-7406-1493); Wei Cheng (0000-0002-0055-2775).

**Author contributions:** Shi XB participated in patient treatment, collection and analysis of the clinical data and writing of the manuscript; Jiang JF participated in patient treatment, data analysis and manuscript revision; Jin FX helped guide the treatment of the patient and research design; Cheng W took part in the patient’s therapy; All authors read and approved the final manuscript.

**Informed consent statement:** Written informed consent was obtained from both the patient and her spouse for publication of this case report.

**Conflict-of-interest statement:** The authors declare that they have no conflicts of interests.

**CARE Checklist:** We have read the CARE Checklist (2016), and this manuscript was prepared and revised according to the CARE Checklist (2016).

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

**Manuscript source:** Unsolicited manuscript

**Corresponding author: Xue-Bing Shi, MD, Attending Doctor,** Department of Hematology and Oncology, Tongling People's Hospital, Bijiashan Road 468, Tongguan District, Tongling 244000, Anhui Province, China. [sxbtlph@163.com](mailto:sxbtlph@163.com)

**Telephone:** +86-562-5838144

**Fax:** +86-562-5838144

**Received:** January 25, 2019

**Peer-review started:** January 25, 2019

**First decision:** March 14, 2019

**Revised:** March 21, 2019

**Accepted:** March 26, 2019

**Article in press:** March 26, 2019

**Published online:** May 6, 2019

**Abstract  
*BACKGROUND***

The Janus kinase 2 (*JAK2*) V617F mutation is common in patients with breakpoint cluster region-Abelson1 (*BCR-ABL1*)-negative myeloproliferative neoplasms, including polycythemia vera, essential thrombocythemia and primary myelofibrosis, but is rarely detected in *BCR-ABL1-*positive chronic myeloid leukemia (CML) patients. Here, we report a CML patient with both a *BCR-ABL1* rearrangement and *JAK2* V617F mutation.

***CASE SUMMARY***

A 45-year-old Chinese woman was admitted to our department with a history of significant thrombocytosis for 20 d. Color Doppler ultrasound examination showed mild splenomegaly. Bone marrow aspiration revealed a karyotype of 46, XX, t(9;22)(q34;q11.2) in 20/20 metaphases by cytogenetic analysis, rearrangement of *BCR-ABL*1 (32.31%) by fluorescent polymerase chain reaction (PCR) and mutation of *JAK2* V617F (10%) by PCR and Sanger DNA sequencing. The patient was diagnosed with CML and *JAK2 V617F* mutation. Following treatment with imatinib for 3 mo, the patient had an optimal response and *BCR-ABL1* (IS) was 0.143%, while the mutation rate of *JAK2* V617F rose to 15%.

***CONCLUSION***

Emphasis should be placed on the detection of *JAK2* mutation when CML is diagnosed to distinguish *JAK2* mutation-positive CML and formulate treatment strategies.

**Key words:** Chronic myeloid leukemia; *JAK2* V617F; *BCR-ABL1*; Imatinib; Myeloproliferative neoplasm; Case report

**© The Author(s) 2019.** Published by Baishideng Publishing Group Inc. All rights reserved.

**Core tip:** The Janus kinase 2 (*JAK2*) V617F mutation is rare in breakpoint cluster region-Abelson1 (BCR-ABL1)-positive chronic myeloid leukemia (CML). We report a female CML patient with a *JAK2* V617F mutation. This rare subset of CML patients often have notable thrombocythemia in addition to more typical CML features. The patient achieved complete hematological response following 2 mo imatinib treatment. After 3 mo of imatinib treatment, the value of BCR-ABL1 (IS) was 0.143%, but the *JAK2* V617F mutation rate rose from 10% to 15%.

**Citation:** Shi XB, Jiang JF, Jin FX, Cheng W. Coexistence of breakpoint cluster region-Abelson1 rearrangement and Janus kinase 2 V617F mutation in chronic myeloid leukemia: A case report. *World J Clin Cases* 2019; 7(9): 1087-1092

**URL:** https://www.wjgnet.com/2307-8960/full/v7/i9/1087.htm

**DOI:** https://dx.doi.org/10.12998/wjcc.v7.i9.1087

**INTRODUCTION**

Chronic myeloid leukemia (CML) is a hematologic malignant neoplasm with clonal proliferation of hematopoietic cells. The specific molecular biologic feature of typical CML corresponds to a translocation between chromosome 9 and chromosome 22 [t(9;22)(q34;q11)], named the Philadelphia (Ph) chromosome, which leads to breakpoint cluster region-Abelson1 (*BCR-ABL1*) rearrangement[1]. The Ph chromosome and/or *BCR-ABL1* rearrangement are necessary for the diagnosis of typical CML[1]. Janus kinase 2 (*JAK2*) V617F mutation is an important biomarker in the diagnosis of myeloproliferative neoplasms (MPNs). According to the literature, the mutation rate of *JAK2* V617F is 90%-95% in polycythemia vera (PV) and about 60% in both essential thrombocythemia (ET) and primary myelofibrosis (PMF)[2]. However, *BCR-ABL1-*positive CML with *JAK2* V617F mutation is very uncommon. Herein, we present a case of CML with both the *BCR-ABL1* rearrangement and *JAK2* V617F mutation.

**CASE PRESENTATON**

***Chief complaints***

On May 29, 2018, a 45-year-old Chinese woman with a history of marked thrombocytosis for 20 d was admitted to the Department of Hematology and Oncology, Tongling People’s Hospital (Anhui Province, China).

***History of present illness***

She had been treated with antibiotics for 3 wk for lobar pneumonia in another hospital before admission to our hospital. Peripheral blood count showed a platelet count of 586 × 109/L at the beginning of anti-infective therapy, which increased to 1109 × 109/L when her pneumonia resolved. She attended our department for hematological evaluation.

***History of past illness***

She had no past history of surgery, anemia or malignant neoplasms and was not taking any medication.

***Personal and family history***

She was married, and her spouse and daughter were both healthy. The family history was unremarkable.

***Physical examination upon admission***

Physical examination showed that the splenic inferior margin was 2 cm under the left arcus costarum.

***Laboratory examinations***

The concentration of lactate dehydrogenase was 364 U/L. Peripheral blood count showed a leukocyte count of 11.46 × 109/L, hemoglobin of 121 g/L, platelet count of 1582 × 109/L and neutrophil count of 7.63 × 109/L. Peripheral blood smear examination showed 2% blasts, 1% myelocytes, 70% mature neutrophils, 3% eosinophils, 7% basophils, 13% lymphocytes and 4% monocytes (Table 1). [Bone marrow cytomorphologic examination](https://www.baidu.com/link?url=7RXDgjsjxdOWAX13P3E18PuC-lck0Ia8eMB5H1HqYaZ1XKVGT08mzj6KYFoGhkxlWqpq31f7C1DbE5xLV1RRILwlk8qCJ87K49ROxbbc9wqz-VXlG93GjP1-RYapBV8BM4hezlMA0vV6lVfo272Mp_&wd=&eqid=e7ecb9d4000594b6000000065b339d68) revealed mild granulocytic hyperplasia of 49%, including 1.5% myelocytes, 5.5% metamyelocytes, 10.5% stab nuclear neutrophils, 22% segmented neutrophils, 1.5% eosinophils, 3% basophils and 5% blasts (Table 1). The leukocyte alkaline phosphatase score was 135 and leukocyte alkaline phosphatase positivity was 92%. Immunophenotyping analysis by flow cytometry revealed 5% blast cells. The reagents applied in flow cytometry mainly consisted of antibodies against CD10, CD19, CD5, CD7, CD13, CD33, HLA-DR, CD38, CD34, CD16, CD11b, CD117, CD36, CD64, CD56, CD14, CD20, CD8, CD3, CD2, CD4, cMPO, cCD22, cCD3, TCRab, TCRgd, CD45RA, CD45RO, CD15，CD11c, CD43 and CD45. Cytogenetic analysis using both the G-banding and R-banding technique demonstrated a karyotype of 46, XX, t(9:22)(q34;q11.2) in 20/20 metaphases examined. The rearrangement of *BCR-ABL1* (P210) was detected by fluorescent polymerase chain reaction (commonly known as PCR), and the *BCR-ABL1/ABL1* ratio was 32.31%. Moreover, the *JAK2* V617F mutation was identified by PCR and Sanger DNA sequencing, and the mutation percentage, which was calculated as [copy-numberJAK2V617F / (copy-numberJAK2V617F + copy-numberwild-type JAK2)], was 10%. Bone marrow biopsy examination showed active proliferation of granulocytic cells and marked hyperplasia of megakaryocytes (Figure 1A). The proliferative megakaryocytes had small cell bodies and decreased karyolobism. Additional immunohistochemistry of bone marrow cells exhibited CD34 (2%+), CD117 (5%+), MPO partial +, CD235a minority +, CD61 + for megakaryocytes and a few scattered CD138 +. Gomori staining was positive (++ - +++) (Figure 1B).

***Imaging examinations***

Color Doppler ultrasound examination showed mild splenomegaly.

**FINAL DIAGNOSIS**

The patient was diagnosed with CML (chronic phase, Sokal 1.68, high risk) and *JAK2* V617F mutation.

**TREATMENT**

Due to severe thrombocytosis, the patient was treated with hydroxyurea (0.5-2.0 g/d), aspirin (0.1 g/d) and platelet separation. On the sixth day of hospitalization, she was administered imatinib (0.4 g/d) due to the detection of the *BCR-ABL1* rearrangement. Her platelet count rapidly decreased, and hydroxyurea and aspirin were discontinued successively.

**OUTCOME AND FOLLOW-UP**

On July 11, 2018, her peripheral blood counts were as follows: leukocytes 3.44 × 109/L, neutrophils 2.11 × 109/L, hemoglobin 117 g/L and platelets 130 × 109/L, and she was discharged from the hospital. After leaving hospital, she continued to take imatinib (0.4 g/d). During regular follow-up, her peripheral blood counts were in the normal reference range, and spleen size returned to normal within 2 mo. After 3 mo of imatinib therapy, bone marrow aspiration was reexamined. Mutation of the *ABL1* kinase domain was negative. Chromosomal karyotype was 46, XX in all 20 metaphases by G-banding, while the karyotype of 46，XX，t(9;22)(q34;q11.2) was identified in 1/16 metaphases by R-banding. The *BCR-ABL1*/*ABL1* ratio decreased to 0.216% and *BCR-ABL1* (IS) was 0.143%, but the percentage of *JAK2* V617F mutation increased to 15%. The patient had an optimal response to imatinib therapy and is continuing to take imatinib.

**DISCUSSION**

MPNs are clonal disorders of hematopoietic stem cells, and they can be divided into *BCR-ABL1-*negative MPN and Ph chromosome and/or *BCR-ABL1* positive CML according to the 2016 World Health Organization classification system for hematopoietic and lymphoid tissue tumors. The former mainly includes *JAK2*/*CALR*/*MPL* mutated MPNs (PV, ET and PMF), chronic neutrophilic leukemia, chronic eosinophilic leukemia and unclassified MPN[2]. As an important marker in the diagnosis of *JAK2*/*CALR*/*MPL* mutated MPNs, the *JAK2* V617F mutation has often been reported in PV, ET and PMF, but rarely in typical CML.

In recent years, a few studies have reported that *BCR-ABL1* rearrangement/Ph chromosome and *JAK2* V617F mutation can coexist in CML patients[3-14]. However, some of these studies failed to examine *JAK2* status at the time of initial diagnosis of CML, but detected *JAK2* V617F mutation with a decrease in *BCR-ABL1* translocation level during treatment with tyrosine kinase inhibitors (TKIs)[3-9], while others discovered concomitant *BCR-ABL1* rearrangement and *JAK2* V617F mutation when CML was diagnosed and before administration of TKIs[5,10-14]. The CML patients with a *JAK2* V617F mutation not only had typical CML characteristics but also had notable thrombocythemia[5-7,9-11], and thrombocytosis even persisted in some patients after obtaining a complete cytogenetic response, major molecular response or deep molecular response after TKI therapy[5,7,11]. Most studies indicated that following TKI treatment, the mutation rate of *JAK2* V617F increased with a decrease in *BCR-ABL1* transcript level in this category of CML patients[7,8,12,13]. Only one study showed that *JAK2* V617F mutation gradually decreased and then disappeared, accompanied by a reduction in *BCR-ABL1* rearrangement[10]. As reported in the literature, *JAK2* V617F mutation affected the curative effect in CML patients, and *JAK2 V617F*-positive CML patients often had a suboptimal response to TKIs[9,10,13]. Pahore *et al*[14]demonstrated that 26.7% of 45 CML patients had a *JAK2* V617F mutation, and the risk of early disease progression in patients with a *JAK2* V617F mutation was significantly higher than that in patients withoutthe *JAK2* V617F mutation.

There is no optimal treatment strategy for *JAK2* V617F-positive CML patients. As described in published reports, TKIs are preferentially administered in this subset of patients[3-12]. To our knowledge, it is unclear whether such cases can benefit from the *JAK2* inhibitor ruxolitinib.

In our patient, bone marrow examination revealed the coexistence of *BCR-ABL1* rearrangement and *JAK2* V617F mutation before imatinib was administered, and the patient also presented with marked megakaryocytic hyperplasia and myelofibrosis. Following hospitalization, peripheral blood primarily showed a marked increase in platelet count. The patient achieved complete hematological response following 2 mo of imatinib treatment. After 3 mo of imatinib treatment, the proportion of Ph chromosome-positive cells was 6.25% in all metaphases and *BCR-ABL1* (IS) was 0.143%, which suggested that the optimum response had been obtained. However, the *JAK2* V617F mutation rate rose from 10% to 15%. The marked thrombocytosis observed at diagnosis and identification of the *JAK2* V617F mutation level increasing in pace with the decrease in *BCR-ABL1* transcript level during imatinib therapy were consistent with previously reported observations[5-9,11-13]. We hypothesize that the coexistence of *BCR-ABL1* rearrangement and *JAK2* V617F mutation originates from two different clones that grow independently. Although our patient has favorable treatment efficacy at present, the *JAK2* V617F mutation level is still increasing and bone marrow fibrosis is still present. Thus, the long-term prognosis of this patient may be poor, and extended follow-up is required.

**CONCLUSION**

With the rapid development of molecular biology, a few CML patients with a *JAK2* V617F mutation have been reported recently, but such cases are relatively rare. The specific pathogenesis, optimal treatment and prognosis of this special type of CML are currently still ambiguous, and further large-sample studies are urgently needed. Moreover, further research to determine whether the *JAK2* mutation is associated with *BCR-ABL1* translocation in these patients is required. Attention should be paid to the detection of the *JAK2* mutation during the diagnosis and treatment of CML in order to timely identify *JAK2* mutation-positive CML patients and guide the formulation of treatment strategies.

**REFERENCES**

1 **Jabbour E**, Kantarjian H. Chronic myeloid leukemia: 2016 update on diagnosis, therapy, and monitoring. *Am J Hematol* 2016; **91**: 252-265 [PMID: 26799612 DOI: 10.1002/ajh.24275]

2 **Barbui T**, Thiele J, Gisslinger H, Kvasnicka HM, Vannucchi AM, Guglielmelli P, Orazi A, Tefferi A. The 2016 WHO classification and diagnostic criteria for myeloproliferative neoplasms: document summary and in-depth discussion. *Blood Cancer J* 2018; **8**: 15 [PMID: 29426921 DOI: 10.1038/s41408-018-0054-y]

3 **Krämer A**, Reiter A, Kruth J, Erben P, Hochhaus A, Müller M, Cross NC, Jones AV, Ho AD, Hensel M. JAK2-V617F mutation in a patient with Philadelphia-chromosome-positive chronic myeloid leukaemia. *Lancet Oncol* 2007; **8**: 658-660 [PMID: 17613428 DOI: 10.1016/S1470-2045(07)70206-1]

4 **Inami M**, Inokuchi K, Okabe M, Kosaka F, Mitamura Y, Yamaguchi H, Dan K. Polycythemia associated with the JAK2V617F mutation emerged during treatment of chronic myelogenous leukemia. *Leukemia* 2007; **21**: 1103-1104 [PMID: 17301812 DOI: 10.1038/sj.leu.2404591]

5 **Darling HS**, Kumar R, Kapoor R, Singh J, Verma T. BCR-ABL and JAK2V617F Mutation Co-existence, Rare or Just Unexplored. *Indian J Hematol Blood Transfus* 2017; **33**: 633-635 [PMID: 29075087 DOI: 10.1007/s12288-017-0781-4]

6 **Pagnano KB**, Delamain MT, Magnus MM, Vassallo J, DE Souza CA, DE Almeida D, Lorand-Metze I. Concomitant essential thrombocythemia with JAK2 V617F mutation in a patient with chronic myeloid leukemia with major molecular response with imatinib and long-term follow-up. *Oncol Lett* 2016; **12**: 485-487 [PMID: 27347169 DOI: 10.3892/ol.2016.4631]

7 **Pastore F**, Schneider S, Christ O, Hiddemann W, Spiekermann K. Impressive thrombocytosis evolving in a patient with a BCR-ABL positive CML in major molecular response during dasatinib treatment unmasks an additional JAK2V617F. *Exp Hematol Oncol* 2013; **2**: 24 [PMID: 24007855 DOI: 10.1186/2162-3619-2-24]

8 **Hussein K**, Bock O, Seegers A, Flasshove M, Henneke F, Buesche G, Kreipe HH. Myelofibrosis evolving during imatinib treatment of a chronic myeloproliferative disease with coexisting BCR-ABL translocation and JAK2V617F mutation. *Blood* 2007; **109**: 4106-4107 [PMID: 17449802 DOI: 10.1182/blood-2006-12-061135]

9 **Hassan A**, Dogara LG, Babadoko AA, Awwalu S, Mamman AI. Coexistence of JAK2 and BCR-ABL mutation in patient with myeloproliferative neoplasm. *Niger Med J* 2015; **56**: 74-76 [PMID: 25657500 DOI: 10.4103/0300-1652.149177]

10 **Campiotti L**, Appio L, Solbiati F, Ageno W, Venco A. JAK2-V617F mutation and Philadelphia positive chronic myeloid leukemia. *Leuk Res* 2009; **33**: e212-e213 [PMID: 19589593 DOI: 10.1016/j.leukres.2009.06.011]

11 **Lewandowski K**, Gniot M, Wojtaszewska M, Kanduła Z, Becht R, Paczkowska E, Mędraś E, Wasilewska E, Iwoła M. Coexistence of JAK2 or CALR mutation is a rare but clinically important event in chronic myeloid leukemia patients treated with tyrosine kinase inhibitors. *Int J Lab Hematol* 2018; **40**: 366-371 [PMID: 29508552 DOI: 10.1111/ijlh.12798]

12 **Xu W**, Chen B, Tong X. Chronic myeloid leukemia patient with co-occurrence of BCR-ABL junction and JAK2 V617F mutation. *Int J Hematol* 2014; **99**: 87-90 [PMID: 24293258 DOI: 10.1007/s12185-013-1480-z]

13 **De Roeck L**, Michaux L, Debackere K, Lierman E, Vandenberghe P, Devos T. Coexisting driver mutations in MPN: clinical and molecular characteristics of a series of 11 patients. *Hematology* 2018; **23**: 785-792 [PMID: 29993347 DOI: 10.1080/10245332.2018.1498182]

14 **Pahore ZA**, Shamsi TS, Taj M, Farzana T, Ansari SH, Nadeem M, Ahmad M, Naz A. JAK2V617F mutation in chronic myeloid leukemia predicts early disease progression. *J Coll Physicians Surg Pak* 2011; **21**: 472-475 [PMID: 21798133]

**P-Reviewer:** Redondo PC, Xavier-Elsas P **S-Editor:** Gong ZM

**L-Editor:** Filipodia **E-Editor:** Wu YXJ

**Specialty type:** Medicine, research and experimental

**Country of origin:** China

**Peer-review report classification**

Grade A (Excellent): A

Grade B (Very good): B

Grade C (Good): 0

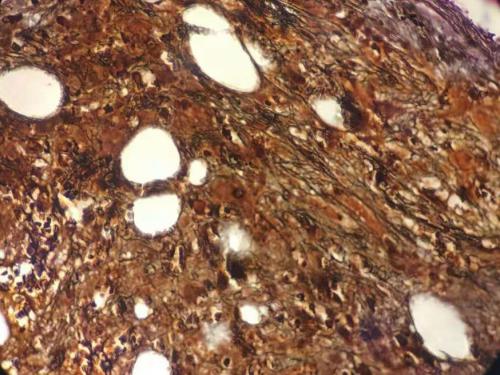
Grade D (Fair): 0

Grade E (Poor): 0

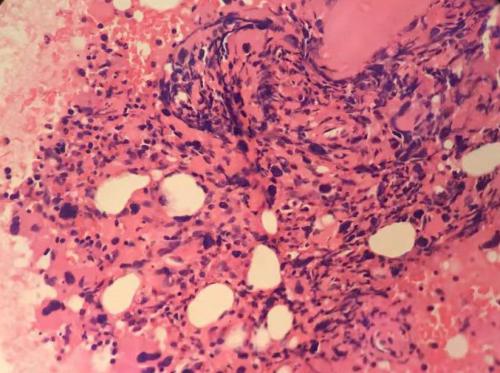
**Table 1 Differential cell counts in peripheral blood and bone marrow**

|  |  |  |
| --- | --- | --- |
| **Cell types** | **Peripheral blood** | **Bone marrow** |
| **Cell counts, %** | **Cell counts, %** |
| Blast | 2 | 5 |
| Myelocyte | 1 | 1.5 |
| Metamyelocyte | NA | 5.5 |
| Mature neutrophil | 70 | 32.5 |
| Stab nuclear neutrophil | NA | 10.5 |
| Segmented neutrophil | NA | 22 |
| Eosinophil | 3 | 1.5 |
| Basophil | 7 | 3 |
| Lymphocyte | 13 | 10.5 |
| Monocyte | 4 | 1 |

NA: Not applicable.



**B**



**A**

**Figure 1 Bone marrow biopsy.** A: Hematoxylin and eosin staining shows active proliferation of granulocytic cells and marked megakaryocytic hyperplasia (400 ×); B: Gomori staining is positive (++ to +++) (400 ×).