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HIGH-THROUGHPUT SEQUENCING AND TARGETED THERAPY IN METACHRONOUS ACUTE MYELOID LEUKEMIA: APPLICATION EXPERIENCE

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ВЫСОКОПРОИЗВОДИТЕЛЬНОЕ СЕКВЕНИРОВАНИЕ И ТАРГЕТНАЯ ТЕРАПИЯ ПРИ МЕТАХРОННЫХ ОСТРЫХ МИЕЛОИДНЫХ ЛЕЙКОЗАХ: ОПЫТ ПРИМЕНЕНИЯ

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An analysis of a case of diagnosis and treatment of acute myeloid leukemia (AML) using the high-throughput sequencing method in a mature patient is presented. The debut of AML (morphological variant – acute promyelocytic leukemia, APL) manifested in patient K., 53 years. Taking into account the AML variant, program chemotherapy with all-trans-retinoic acid (ATRA) in combination with idarubicin was performed. The first long-term remission was achieved. At the 26th month of follow-up, the patient had recurrent anemia, thrombocytopenia, and leukopenia in combination with blasts in peripheral blood analysis. The relapse of leukemia was suspected. However, morphological typing verified the AML with maturation, and the translocation t (6;11) was detected in the leukemic blasts. The second remission induction was complicated by a severe herpes infection, COVID-19, pneumonia with pan-resistant bacterial microflora, and fungal lung infection. Six chemotherapy courses were performed, including cytarabine, daunorubicin, ATRA, interferon, venetoclax, azacitidine, and etoposide. However, the second remission, taking into account the persistence of the leukemic clone according to the residual disease monitoring results, was not achieved. The total follow-up duration was 34 months, including the duration of therapy for containment of the second metachronous AML, which was seven months.

Keywords: acute myeloid leukemia, metachronous tumor, mutations, genotyping, sequencing, age

Приведен анализ случая диагностики и лечения острого миелоидного лейкоза (ОМЛ) с применением метода высокопроизводительного секвенирования у больного зрелого возраста. Впервые ОМЛ (морфологический вариант – острый промиелоцитарный лейкоз) манифестировал у больного К., 53 лет. С учетом варианта ОМЛ проводилась программная химиотерапия полностью трансретиноевой кислотой (ATRA) в сочетании с идарубицином. Была достигнута первая продолжительная ремиссия. На 26-м месяце наблюдения у больного выявлена анемия, тромбоцитопения, лейкопения в сочетании с бластемией, заподозрен рецидив лейкоза. Однако при морфологическом

типировании верифицирован ОМЛ с созревaniem, в лейкозных клетках выявлена транслокация t (6; 11). Индукция второй ремиссии осложнилась тяжелой герпетической инфекцией, COVID-19, пневмонией с высевом панрезистентной бактериальной микрофлоры и грибковым поражением легких. Проведено 6 курсов химиотерапии с включением цитарабина, даунорубина, ATRA, интерферона, венетоклакса, азацитидина, этопозиды. Однако вторая ремиссия, с учетом сохранения лейкозного клона по результатам мониторинга остаточной болезни, не была достигнута. Общая продолжительность наблюдения составила 34 месяца, в т. ч. продолжительность терапии сдерживания второго метакронного ОМЛ – 7 месяцев.

Ключевые слова: острый миелоидный лейкоз, метакронная опухоль, мутации, генотипирование, секвенирование, возраст

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AML – acute myeloid leukemia
APL – acute promyelocytic leukemia
ATRA – all-trans-retinoic acid

FISH – fluorescent in situ hybridization
RT-PCR – real time polymerase chain reaction

Diagnosis and treatment of secondary acute myeloleukemia (AML), including metachronous leukemia, is one of the most challenging tasks of hematology. The traditional method of treatment for patients with AML with unfavorable prognosis is intensive polychemotherapy in combination with targeted drugs followed by bone marrow transplantation. However, most patients have medical contraindications to intensive treatment due to age, comorbidities, and toxic complications. Therefore, palliative pharmacological strategies based on tumor cell genotyping can effectively prolong the life of patients with AML, even without complete remission [1, 2].

This study aimed to analyze a case of diagnosis and treatment of metachronous AML detected by high-throughput sequencing in a middle-aged patient.

Clinical case. Bone marrow and peripheral blood samples from patient K., man, 53 years old, who was treated with targeted chemotherapy for metachronous AML at the Sverdlovsk Regional Hematology Center, were examined. The follow-up duration was 34 months.

The diagnosis of AML was based on clinical symptoms, cytological analysis of blood and bone marrow, blast cytochemistry, and immunophenotyping [2, 3]. Cytogenetic analysis, including fluorescent in situ hybridization (FISH), real time polymerase chain reaction (RT-PCR) for specific chromosomal aberrations [4] and detection of mutations in 141 genes using high-throughput sequencing on the MiSeqDx automatic genetic analyzer performed using the QIAseq Targeted DNA Human Myeloid Neoplasms Panel.

Clinical manifestations, including sore throat, febrile fever, and hemorrhagic syndrome (profuse petechial rash, gastric bleeding, intracerebral right parietal hematoma) were identified in June 2021.

In the peripheral blood test, the hemoglobin level was 63 g/l, leukocytes – $29.0 \times 10^9/\mu\text{l}$ (blasts – 64.0 %, atypical promyelocytes – 33.0 %), platelets – $15 \times 10^3/\mu\text{l}$. In the bone marrow, with a cell content of 90 000/ μl , blast cells accounted for 18.0 %, atypical promyelocytes (equivalent to blasts [1, 2]) – 74.0 %. Cytochemical reactions to lipids and glycogen were positive in 100.0 % of blasts and atypical promyelocytes. Immunophenotypically,

leukemic cells were characterized by CD13, CD33, CD45, CD117 and MPO expression. Based on the results of morphological examination, AML, subtype M3 (acute promyelocytic leukemia, APL) was verified.

A standard cytogenetic analysis (G-banding) identified a low mitotic index, and it was impossible to specify the karyotype variant. In the FISH analysis of 100 nuclei, the signal of the chimeric PML/RAR gene was detected in 90.0 %. The transcript of the chimeric PML/RARA gene, variant bcr3, was also detected by RT-PCR, with a relative expression level of 7.91 %. Mutations of D835 in the FLT3 gene, internal tandem duplications of FLT3, and insertions in the NPM1 gene were not detected.

A clinically significant mutation c. 35G>T (allele burden 44.0 %) in the NRAS gene was detected using high-throughput sequencing, determining the amino acid substitution p. Gly12Val in the encoded protein. In addition, three mutations were identified in the coding sequences of the STXBP2 and TPMT genes that cause the amino acid substitutions with an allele burden of 52.0 % for each one. However, the pathogenetic significance of the STXBP2 and TPMT mutations has not been established in AML [1, 5]. The coding sequences of the remaining studied genes corresponded to the reference ones.

The treatment was applied according to the AIDA chemotherapeutic regimen, which included three targeted courses of induction-consolidation using all-trans-retinoic acid (ATRA) and idarubicin. In the post-cytostatic period, herpetic dermatitis and neutropenic fever were observed, for which the patient received broad-spectrum antibiotics and anti-herpetic and antifungal drugs. On the 28th day of the AIDA program, the count of blast cells in the bone marrow aspirate was 2.0 %, and the first remission was achieved. After ending the third course of the AIDA program, remission persisted, and transcripts of the chimeric PML/RARA gene were not detected using the RT-PCR method. Since November 2021, the patient has been included in maintenance chemotherapy until July 2023 while maintaining hematological and molecular remission of AML.

In July 2023 (the 25th month of follow-up), the WBC test showed leukopenia; later, the patient noticed

weakness and shortness of breath during physical exertion. A month later, in the peripheral blood, the hemoglobin level was 96 g/l, leukocytes – $1.5 \times 10^9/\mu\text{l}$ (blasts – 15.0 %, atypical promyelocytes were not detected), and platelets – $35 \times 10^3/\mu\text{l}$. The bone marrow blast cells accounted for 41.0 % and promyelocytes for 1.0 % at $98\,000/\mu\text{l}$ cellularity. During a cytochemical examination, lipids were positive in 43.0 % and glycogen – in 98.0 % of blasts. Immunophenotypically, leukemic cells were characterized by the expression of CD13, CD33, CD45, CD117, MPO, CD99, HLA-DR, Lysozyme, CD11a, and CD371. Based on the results of morphological examination, AML, subtype M2 (acute myeloblastic leukemia with maturation) was verified.

A standard cytogenetic study (G-banding) determined the divergention of aberrant and normal karyotype 46, XY, t (6; 11)(q27;q23) / 46, XY. In the FISH analysis of 100 nuclei, the signal of the chimeric KMT2A/AFDN gene corresponding to the translocation t (6; 11) was detected in 80 %. The transcript of the chimeric KMT2A/AFDN gene was also identified using RT-PCR. At the same time, BCR-ABL, PML-RARa, CBFB-MYH11, RUNX1-RUNX1T1, MLL-MLLT3, DEK-NUP214, D835 mutations in the FLT3 gene, internal tandem duplications of FLT3 and insertions in the NPM1 gene were not detected.

Due to the unfavorable prognosis and the absence of related and unrelated HLA-matched donors, it was decided to appoint a course of induction according to the «7+3» scheme: cytarabine 200 mg 2/day for 1–7 days in combination with daunorubicin 120 mg intravenously for 1–3 days. On the 6th day of treatment, an episode of fever was noted, and RT-PCR detected the RNA of the SARS-CoV2 virus. Therefore, after ending the chemotherapy program, the patient was hospitalized at the COVID-19 hospital for further treatment. The course of COVID-19 infection was complicated by bilateral pneumonia of viral-bacterial and fungal etiology (*Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, herpes simplex virus, Epstein-Bar virus were found in crops), for which the patient received broad-spectrum antibacterial, antifungal drugs and acyclovir. Due to the absence of remission on +24 days (undifferentiated blasts accounted for 25 % in the bone marrow aspirate), taking into account the persistent pancytopenia and infectious foci in the lung, it was decided to conduct the 2nd course of induction according to the «Ven+Aza» regimen using targeted drugs venetoclax 200 mg orally 1–28 days and azacitidine 150 mg subcutaneously for 1–5 days. In the control bone marrow smear at the end of treatment, the blast level was 4.2 %, pancytopenia, and infectious complications persisted. With this in mind, ATRA 90 mg orally for 1–5 days and interferon 3 million on days 1, 3, and 5 were used as the 3rd course of chemotherapy. During cytological examination in the bone marrow specimen +10 days after the end of the «ATRA+ interferon» course, the level of undifferentiated blasts was 9.8 %. According to an X-ray examination, bilateral pneumonia had a positive dynamic, although temperature spikes to 38.5 °C persisted.

In December 2023, the patient underwent the 4th course of chemotherapy according to the scheme: low doses of cytarabine 20 mg 2/day subcutaneously for 1–10 days and venetoclax 50 mg/day orally for 25 days. In January 2024, the 5th course of targeted therapy was conducted using azacitidine in combination with venetoclax while taking voriconazole. In the control bone marrow specimen, the blasts were 8.6 %, in the blood test was persisted leukopenia $1.8 \times 10^9/\mu\text{l}$ (blasts – 7.0 %), anemia (hemoglobin 108 g/l), platelets – $164 \times 10^3/\mu\text{l}$. The 6th course of chemotherapy was the «venetoclax

+ etoposide + ATRA» regimen in combination with the prevention of fungal complications by posaconazole.

Discussion. In the case study of metachronous AML (APL in June 2021, AML M2 in September 2023), high-throughput sequencing revealed the c. 35G>T mutation in the NRAS gene is essential as an earlier event in AML [5, 6]. In addition, leukemia-specific chromosomal aberrations were determined for each metachronous AML. The chimeric PML/RARa gene, bcr3 variant, corresponding to the translocation t (15; 17), was in APL, and the KMT2A/AFDN transcript, corresponding to the translocation t (6; 11), was in AML M2, respectively.

The patient's family medical history revealed that the patient's mother, two aunts, and grandmother had died of malignant neoplasms (pancreatic cancer, breast cancer, gastric cancer, and lung cancer, respectively). This may indicate the presence of a hereditary predisposition to neoplasms in the probands' family. At the same time, the symptoms of the classic RASopathy [1, 2] were not revealed.

APL is a highly aggressive tumor of myeloid tissue, the substrate of which is atypical promyelocytes. Its pathogenesis is associated with rearrangements between genes encoding the retinoic acid receptor alpha (RARa) or other targets of retinoic acid receptors (RAR) and several partner genes [7]. One of the most common rearrangements is a reciprocal translocation between chromosome 15 and 17 t (15; 17)(q24; q21), which leads to the formation of the chimeric PML/RARa gene [8]. Currently, available therapeutic options, including the use of drugs in combination with ATRA and chemotherapy, make it possible to achieve a high frequency of complete remission, relapse-free, and overall survival of APL [9]. However, despite reasonable survival rates, patients may develop second malignancies after chemotherapy, which may be due to exposure to alkylating agents or DNA topoisomerase II inhibitors [6, 10]. At the physiological level, retinoids have a protective effect against tumor neoplasms, but at the supraphysiological level, ATRA can promote oncogenesis [11]. Several cases of secondary renal cell carcinoma and T-lymphoblastic lymphoma after APL patients' chemotherapy have been described [12, 13].

Several studies have found myeloid neoplasms and, in particular, those associated with AML and MDS therapy in patients who had a long-term relapse-free course of APL against the background of ATRA therapy [14, 15]. It is important to note that APL patients over 40 years ago were associated with the occurrence of a second malignant neoplasm [6]. Patients aged 40 years or more at the time of diagnosis had a 5.1 times higher risk of developing secondary malignancies compared with patients who were younger than 40 years [14].

Observation of 160 patients with APL revealed the presence of secondary malignant neoplasm in 11. The time from the diagnosis of APL to the occurrence of a secondary malignant neoplasm was from 16–125 months. The spectrum of secondary tumors in patients treated with ATRA + idarubicin included MDS, breast, vulva, colon, prostate, and sarcoma, and their incidence was 17 % [10].

Clinical observations of patients with AML development after APL therapy according to the standard scheme indicate an unfavorable prognosis of metachronous AML with a median overall survival of 10 months. In addition, the issue of the lack of effective therapy for metachronous AML remains essential [5, 6].

In our observation, a middle-aged patient achieved remission after APL therapy with ATRA and idarubicin. However, against the background of supportive

treatment, on the 26th month of follow-up, the patient is diagnosed with AML M2 with translocation t (6; 11). As a result of 6 courses of chemotherapy using targeted drugs, the patient persists the blasts in the bone marrow and peripheral blood, as well as three-lineage cytopenia.

Concerning the AML subtype, the older age preceding APL mutation t (6; 11) is associated with worse outcomes. When choosing a treatment, of course, the «7+3» scheme is associated with better survival; however, as a result of severe infectious complications, it was decided to change therapy using venetoclax, ATRA, and low-dose cytarabine. However, according to the data available, this combination does not lead to continuous remissions in adult AML patients with translocation t (6; 11).

Thus, considering the underlying disease and comorbidities, the chosen therapy regimen was reasonable for the patient. Still, the patient's molecular genetic profile was associated with an unfavorable prognosis, and remission was not achieved.

Conclusion. The possibility of various morphological and genetic variants of AML in a middle-aged patient was established: APL at the onset of the disease, followed by the AML M2 with translocation t (6; 11) at the 26th month of follow-up. Personalization of the chemotherapeutic strategy based on high-throughput sequencing data and inclusion of targeted therapy allowed to achieve tumor containment in the patient despite the unfavorable genetic prognosis of AML and the absence of a second remission.

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References

1. Arber D. A., Orazi A., Hasserjian R. P., Borowitz M. J., Calvo K. R. [et al.] International consensus classification of myeloid neoplasms and acute leukemias: integrating morphologic, clinical, and genomic data. *Blood*. 2022;140(11):1200-1228. <https://doi.org/10.1182/blood.2022015850>
2. Khoury J. D., Solary E., Abla O., Akkari Y., Alaggio R. [et al.] The 5th edition of the World Health Organization classification of haematolymphoid tumours: Myeloid and Histiocytic/Dendritic Neoplasms. *Leukemia*. 2022;36(7):1703-1719. <https://doi.org/10.1038/s41375-022-01613-1>
3. Vinogradov A. V., Rezaykin A. V., Sazonov S. V., Sergeev A. G., Kapitonova M. Yu. Molecular genetic analysis of ASXL1, FLT3, KIT, NPM1, NRAS, TP53 and WT1 mutations in acute myeloid leukemia patients 45–60 years old. *Medical News of North Caucasus*. 2020;15(1):32-36. <https://doi.org/10.14300/mnnc.2020.15006>
4. Vinogradov A. V., Rezaykin A. V., Sazonov S. V., Shchetinin E. V., Bobryshev D. V. [et al.] Mutational status of acute myeloblastic leukemia with maturation (M2) in adult patients. *Medical News of North Caucasus*. 2021;16(1):18-21. <https://doi.org/10.14300/mnnc.2021.16005>
5. Sperling A., Gibson C., Ebert B. The genetics of myelodysplastic syndrome: from clonal haematopoiesis to secondary leukaemia. *Nat. Rev. Cancer*. 2017;17:5-19. <https://doi.org/10.1038/nrc.2016.112>
6. Lenzi L., Lee-Jones L., Mostofa M. A., de Andrade D. P., Ribeiro R. C., Figueiredo B. C. Second primary malignancy after acute promyelocytic leukemia: a population-based study. *Cancers (Basel)*. 2020;12(12):3610. <https://doi.org/10.3390/cancers12123610>
7. Mannan A., Muhsen I. N., Barragán E., Sanz M. A., Mohanty M. [et al.] Genotypic and phenotypic characteristics of acute promyelocytic leukemia translocation variants. *Hematol. Oncol. Stem Cell Ther.* 2020;13(4):189-201. <https://doi.org/10.1016/j.hemonc.2020.05.007>
8. Coombs C. C., Tavakkoli M., Tallman M. S. Acute promyelocytic leukemia: where did we start, where are we now, and the future. *Blood Cancer J.* 2015;5(4):e304. <https://doi.org/10.1038/bcj.2015.25>
9. Gill H., Yim R., Lee H. K. K., Mak V., Lin S. Y. [et al.] Long-term outcome of relapsed acute promyelocytic leukemia treated with oral arsenic trioxide-based reinduction and maintenance regimens: A 15-year prospective study. *Cancer*. 2018;124(11):2316-2326. <https://doi.org/10.1002/cncr.31327>
10. Eghtedar A., Rodriguez I., Kantarjian H., O'Brien S., Daver N. [et al.] Incidence of secondary neoplasms in patients with acute promyelocytic leukemia treated with all-trans retinoic acid plus chemotherapy or with all-trans retinoic acid plus arsenic trioxide. *Leuk. Lymphoma*. 2015;56(5):1342-1345. <https://doi.org/10.3109/10428194.2014.953143>
11. Latagliata R., Petti M. C., Fenu S., Mancini M., Spiriti M. A. [et al.] Therapy-related myelodysplastic syndrome-acute myelogenous leukemia in patients treated for acute promyelocytic leukemia: an emerging problem. *Blood*. 2002;99(3):822-824. <https://doi.org/10.1182/blood.v99.3.822>
12. Lobe I., Rigal-Huguet F., Vekhoff A., Desablens B., Bordessoule D. [et al.] European APL group experience. Myelodysplastic syndrome after acute promyelocytic leukemia: the European APL group experience. *Leukemia*. 2003;17(8):1600-1604. <https://doi.org/10.1038/sj.leu.2403034>
13. Szołkowski T., Jarosova M., Faber E., Hubacek J., Hlusi A. [et al.] Precursor T-lymphoblastic lymphoma as a secondary malignancy in a young patient after successful treatment of acute promyelocytic leukemia. *Onkologie*. 2009;32(8-9):513-515. <https://doi.org/10.1159/000226584>
14. Lenzi L., Lee-Jones L., Mostofa M. A., de Andrade D. P., Ribeiro R. C., Figueiredo B. C. Second Primary Malignancy after Acute Promyelocytic Leukemia: A Population-Based Study. *Cancers (Basel)*. 2020;12(12):3610. <https://doi.org/10.3390/cancers12123610>
15. Carratù M. R., Marasco C., Mangialardi G., Vacca A. Retinoids: novel immunomodulators and tumour-suppressive agents? *Br. J. Pharmacol.* 2012;167(3):483-492. <https://doi.org/10.1111/j.1476-5381.2012.02031.x>

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3D TECHNOLOGY IN SURGERY OF LUNG HYDATID CYST

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ИСПОЛЬЗОВАНИЕ 3D-РЕКОНСТРУКЦИИ В ХИРУРГИЧЕСКОМ ЛЕЧЕНИИ ЭХИНОКОККОВОЙ КИСТЫ ЛЕГКОГО

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We present the results of using 3D technology to improve visualization and planning of the lung hydatid cyst (LHC) surgery in a 12-year-old girl. The general physical examination was unremarkable. The 3D reconstruction of the lungs was performed based on CT DICOM files. The most reliable data were obtained with CT with an Air and Fat filter. Based on the performed 3D reconstruction, a multiport thoracoscopic pulmonary echinococectomy was performed. Thoracoscopy revealed an LHC in the left lung's posterior basal segment. Using a linear cutter stapler with two staple leg lengths of 45 mm/60 mm, cyst excision was performed. At the same time, it was possible to reduce the intervention volume and eliminate the bronchial fistula leading to the LHC. Therefore, applying AI technology to the left lung with a parasite cyst allowed for more precise visualization and successful LHC surgery.

Keywords: hydatid cyst, lung, 3D, AI, video-assisted thoracoscopic surgery, echinococcosis, thoracic surgery

Представлены результаты использования 3D-реконструкции для улучшения результатов лечения эхинококковой кисты легкого (ЭКЛ) у девочки 12 лет. 3D-реконструкция легких была выполнена на основе файлов КТ DICOM. Наиболее достоверные данные были получены при КТ с воздушным и жировым фильтром. По результату реконструкции выполнена многопортовая торакоскопическая эхинококкэктомия слева. При торакоскопии выявлена ЭКЛ, расположенная в заднем базальном сегменте левого легкого. С помощью двух кассет линейного степлера (60 мм и 45 мм) выполнена резекция легкого с паразитарной кистой. При этом удалось не только уменьшить объем вмешательства, но и ликвидировать бронхиальный свищ, обнаруженный при 3D-реконструкции. Таким образом, использование технологий искусственного интеллекта позволило улучшить не только визуализацию, но и провести успешную операцию у пациентки с ЭКЛ.

Ключевые слова: эхинококкоз, легкие, 3D, искусственный интеллект, видеоассистированная торакоскопия, торакальная хирургия