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XN-Series

Automated Hematology Analyzer

Clinical Case Report Vol. 1

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XN

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We Believe the Possibilities.

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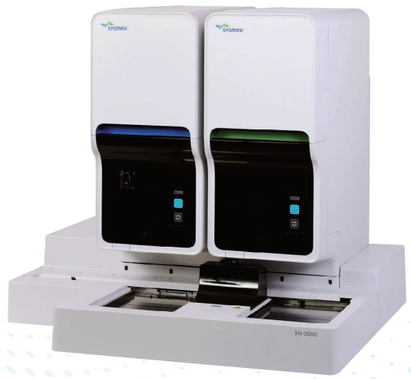

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ENG

* The intent of instrument generated flags is limited to the identification of specimens containing abnormal cells, subject to review by qualified laboratory personnel.

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Prefatory note

The examination of peripheral blood is routinely used as a basic test in daily medical practice. It plays a role as the initial step in the evaluation of hematological conditions and diseases, providing data in screening for anemia and infections, and information leading to the differentiation of pathological conditions and the confirmation of diagnoses. Thus, an automated hematology analyzer system needs to have functions to determine and analyze each blood cell count and parameters related to blood cell morphology and size. In the development of analyzer systems, technological advancement has enabled, one after another, the automated classification of white blood cells, measurement of reticulocytes and measurement of immature platelets (reticulated platelets). Their performance has been improved to enable the measurement of multiple parameters and to hold multiple functions, including abnormal cell detection and body fluid analysis. Furthermore, high-throughput processing has been made possible.

Sysmex Corporation is releasing the automated hematology analyzers of the newly developed XN-Series. In this new series, the performance of the conventional functions has been improved, and some new functions have been added. It shows enhanced precision in blood cell counting because of the adoption of a new fluorescent dye for platelet counting (PLT-F channel), a nucleated red blood cell correction function for white blood cell counting in all specimens (WNR channel), and a newly added measurement mode for specimens with low numbers of white blood cells (LW mode). In the white blood cell differentiation (WDF) channel and abnormal cell detection (WPC) channel, optimization of the reagent reaction, signal processing and analysis algorithms have improved the performance in cell differentiation and detection as well as in flagging (IP messages). However, there are limitations similar to those of the earlier automated hematology analyzer systems in the detection of abnormal cells. This booklet was prepared as an attempt to help users of the new analyzer system to understand the multiple functions of the analyzer and the many parameters it can measure by means of clinical case data. Firstly, it describes the measurement principle for each parameter, the reagent reaction in each channel, the records generated and their significance. In the following section of case reports, clinical laboratory test findings and micrographs of peripheral blood smears necessary for diagnosis and understanding the pathogenesis are shown along with the blood cell counts, flags and scattergrams of different channels for typical hematological diseases and conditions. Comparison of the data generated by the analyzer with visual cell differentiation and blood cell morphology findings (micrographs) helps with the interpretation of cell distribution abnormalities seen in the scattergrams. In the description of each case the interpretation of blood cell morphology and laboratory findings as well as the basis of the differential diagnosis are given. Additional information includes the points to be noted when there is a flag and a cell distribution abnormality in the scattergram, or when data and scattergrams generated by the analyzer strongly differ from the microscopic information. The WHO disease classification and description of hematopoietic tumors, published in 2008, which is based on advances in the elucidation of molecular pathogeneses and their clinical implications, has been applied throughout this booklet.

For the daily routine of hematological testing using this analyzer it is important to interpret the data generated for each specimen, namely the blood cell count abnormalities, flagging information and cell distribution abnormalities in the scattergrams, in order to detect abnormalities at an early stage and take appropriate measures. Together with microscopic findings of the blood cell morphology this provides useful information. The cases reported here are typical examples of only a limited number of diseases. It can be expected that flagging details and cell distribution abnormalities in the scattergrams vary from one case to another of the same disease, as they vary depending on the stage of the disease and any treatment intervention. Therefore, the case data reported here are intended for reference use only, and I hope that each institution will deepen its understanding of the functions of this analyzer and the parameters measured by it by analyzing many cases and conditions. It would be my pleasure if this booklet helps the users to understand the parameters and functions of this new analyzer and contributes to their routine work of blood testing as a source of reference information.

May 2011

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Department of Laboratory Medicine, Tokai University School of Medicine and
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Contents

Measurement principles and analysis parameters

Whole blood mode

Analysis channel	Principles	Analysis parameter	Meanings
WNR Dilution 1:61	Flow cytometry method using semiconductor laser	WBC	White blood cell (leukocyte) count
		BASO#	Basophil count
		BASO%	Basophil percent
		NRBC#	Nucleated red blood cell count
		NRBC%	Nucleated red blood cell percent
WDF Dilution 1:61		NEUT#	Neutrophil count
		NEUT%	Neutrophil percent
		LYMPH#	Lymphocyte count
		LYMPH%	Lymphocyte percent
		MONO#	Monocyte count
		MONO%	Monocyte percent
		EO#	Eosinophil count
		EO%	Eosinophil percent
		IG#	Immature granulocyte count
		IG%	Ratio of IG# to WBC
WPC Dilution 1:61		—	
RET Dilution 1:204		RET# *	Reticulocyte count
		RET% *	Reticulocyte percent
		IRF *	Immature reticulocyte fraction
		LFR *	Low fluorescence ratio
		MFR *	Medium fluorescence ratio
		HFR *	High fluorescence ratio
		RET-He *	Reticulocyte hemoglobin equivalent
		PLT-O *	Platelet count (measured by RET channel)
PLT-F Dilution 1:204		PLT(PLT-F) *	Platelet count (measured by PLT-F channel)
		IPF *	Immature platelet fraction
RBC/PLT Dilution 1:498	Sheath flow DC detection method	RBC	Red blood cell (erythrocyte) count
		HCT	Hematocrit
		MCV	Mean corpuscular volume
		RDW-SD	Red cell distribution width (standard deviation)
		RDW-CV	Red cell distribution width (coefficient of variation)
		PLT-I	Platelet count (measured by RBC/PLT channel)
		PDW	Platelet distribution width
		MPV	Mean platelet volume
		PCT	Plateletcrit
		P-LCR	Platelet large cell ratio
RBC/ PLT & HGB		MCH	Mean corpuscular hemoglobin
		MCHC	Mean corpuscular hemoglobin concentration
HGB Dilution 1:747	SLS-Hemoglobin Method	HGB	Hemoglobin concentration

* These items do not appear with all analyzer types.

Body fluid mode

Analysis channel	Principles	Analysis parameter	Meanings
WDF Dilution 1:20	Flow cytometry method using semiconductor laser	WBC-BF	White blood cell (leukocyte) count
		MN#	Mononuclear count
		MN%	Mononuclear percent
		PMN#	Polymorphonuclear count
		PMN%	Polymorphonuclear percent
		TC-BF#	Total nucleated cell count
RBC Dilution 1:498	Sheath flow DC detection method	RBC-BF	Red blood cell (erythrocyte) count

(The body fluid analysis can only be performed if the instrument offers the body fluid mode.)

Research parameters

Whole blood mode

Analysis channel	Research parameter	Meanings
WNR	WBC-N	WBC count calculated from the WNR channel.
	TNC-N	The total nuclear cell count (WBC#+NRBC#) calculated from the WNR channel.
	BA-N#	The basophil counts calculated from the WNR channel.
	BA-N%	The basophil percent calculated from the WNR channel.
WDF	WBC-D	WBC count calculated from the WDF channel.
	TNC-D	The total nuclear cell count (WBC#+NRBC#) calculated from the WDF channel.
	NEUT#&	The number of particles obtained by subtracting the IG count from the NEUT count.
	NEUT%&	The ratio of the count obtained by subtracting IG# from NEUT# to the WBC count.
	LYMP#&	The number of particles obtained by subtracting the HFLC count from the LYMPH count.
	LYMP%&	The ratio of the count obtained by subtracting HFLC# from LYMPH# to the WBC count.
	HFLC#	The count of the upper LYMPH area of the WDF scattergram.
	HFLC%	The ratio of the count of the upper LYMPH area of the WDF scattergram to the WBC count.
	BA-D#	The basophil counts calculated from the WDF channel.
	BA-D%	The basophil percent calculated from the WDF channel.
	NE-SSC	The lateral scattered light intensity of the NEUT area on the WDF scattergram.
	NE-SFL	The fluorescent light intensity of the NEUT area on the WDF scattergram.
	NE-FSC	The forward scattered light intensity of the NEUT area on the WDF scattergram.
	LY-X	The lateral scattered light intensity of the LYMPH area on the WDF scattergram.
	LY-Y	The fluorescent light intensity of the LYMPH area on the WDF scattergram.
	LY-Z	The forward scattered light intensity of the LYMPH area on the WDF scattergram.
	MO-X	The lateral scattered light intensity of the MONO area on the WDF scattergram.
	MO-Y	The fluorescent light intensity of the MONO area on the WDF scattergram.
	MO-Z	The forward scattered light intensity of the MONO area on the WDF scattergram.
	NE-WX	The lateral scattered light distribution width of the NEUT area on the WDF scattergram.
	NE-WY	The fluorescent light distribution width of the NEUT area on the WDF scattergram.
	NE-WZ	The forward scattered light distribution width of the NEUT area on the WDF scattergram.
	LY-WX	The lateral scattered light distribution width of the LYMPH area on the WDF scattergram.
	LY-WY	The fluorescent light distribution width of the LYMPH area on the WDF scattergram.
	LY-WZ	The forward scattered light distribution width of the LYMPH area on the WDF scattergram.
	MO-WX	The lateral scattered light distribution width of the MONO area on the WDF scattergram.
	MO-WY	The fluorescent light distribution width of the MONO area on the WDF scattergram.
	MO-WZ	The forward scattered light distribution width of the MONO area on the WDF scattergram.
WPC	WBC-P*	The WBC count calculated from the WPC channel.
	TNC-P*	The total nuclear cell count (WBC#+NRBC#) calculated from the WPC channel.
RET	RBC-He*	The correlation between RBC-Y (the intensity of the lateral fluorescent light of the mature red blood cells) and MCH to convert RBC-Y into [pg] units.
	Delta-He*	Delta-He is calculated by the equation Delta-He = RET-He - RBC-He.
	RET-Y*	The intensity of forward scattered light in the RET area of the RET scattergram.
	RET-RBC-Y*	The intensity of forward scattered light in the RBC (mature red blood cell) area of the RET scattergram.
	IRF-Y*	The intensity of forward scattered light from the IRF area on the RET scattergram.
	RPI*	Reticulocyte Production Index.
	RET-UPP*	The count in the UPP area of the RET scattergram.
	RET-TNC*	The count in the TNC area of the RET scattergram.
	Hypo-He*	The ratio of the count in the low level area of the forward scattered light signal in the RBC (mature red blood cell) area of the RET scattergram to mature red blood cells.
	Hyper-He*	The ratio of the count in the high level area of the forward scattered light signal in the RBC (mature red blood cell) area of the RET scattergram to mature red blood cells.
	RBC-O*	RBC count calculated from the RET channel.
	FRC#*	The absolute count calculated from the count in a specific area below the RBC area in the RET scattergram.
	FRC%*	The ratio calculated from the count in a specific area below the RBC area in the RET scattergram.
PLT-F	IPF#*	The platelet count in the IPF area of the PLT-F scattergram.
	H-IPF*	The ratio to the total platelet count of the count of platelets that appear in the area of stronger fluorescent light intensity within the IPF on the PLT-F scattergram.
RBC	MicroR	Micro RBC ratio.
	MacroR	Macro RBC ratio.

* These items do not appear with all analyzer types.

Body fluid mode

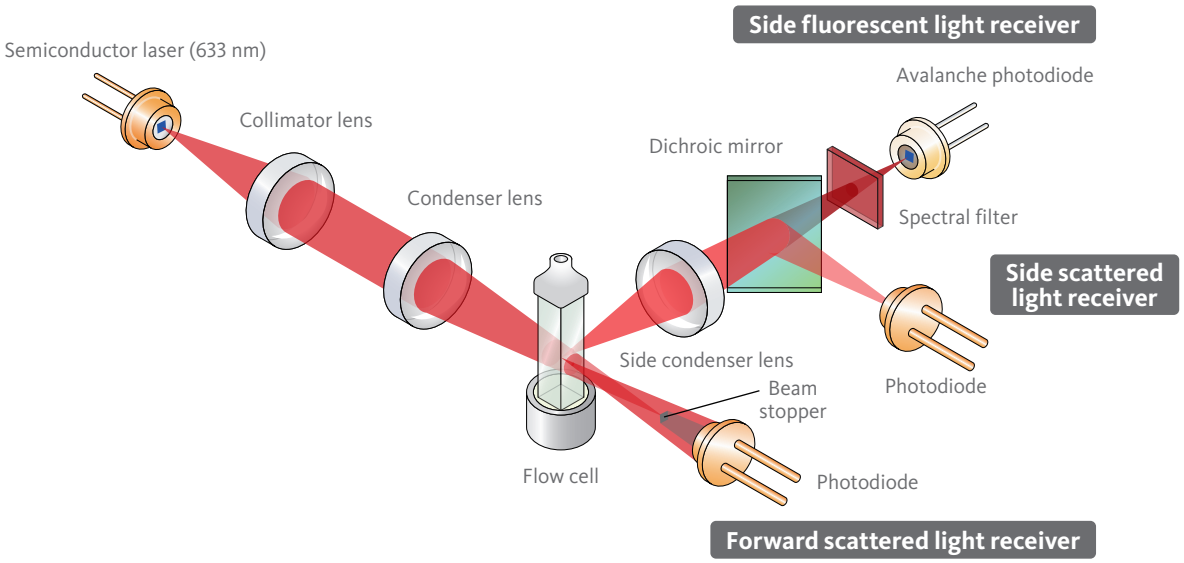
Analysis channel	Research Parameter	Meanings
WDF	HF-BF#	The count in the area with stronger fluorescence than the WBC-BF area of the WDF scattergram.
	HF-BF%	HF-BF count divided by WBC-BF and expressed as a percentage.
	NE-BF#	The count in the NEUT area of the WDF scattergram.
	NE-BF%	NE-BF count divided by WBC-BF and expressed as a percentage.
	LY-BF#	The count in the LYMPH area of the WDF scattergram.
	LY-BF%	LY-BF count divided by WBC-BF and expressed as a percentage.
	MO-BF#	The count in the MONO area of the WDF scattergram.
	MO-BF%	MO-BF count divided by WBC-BF and expressed as a percentage.
	EO-BF#	The count appearing in the EO area of the WDF scattergram.
	EO-BF%	The count in the EO area of the WDF scattergram.
RBC	RBC-BF2	RBC in the body fluid mode with a minimum of 100/μL displayed.

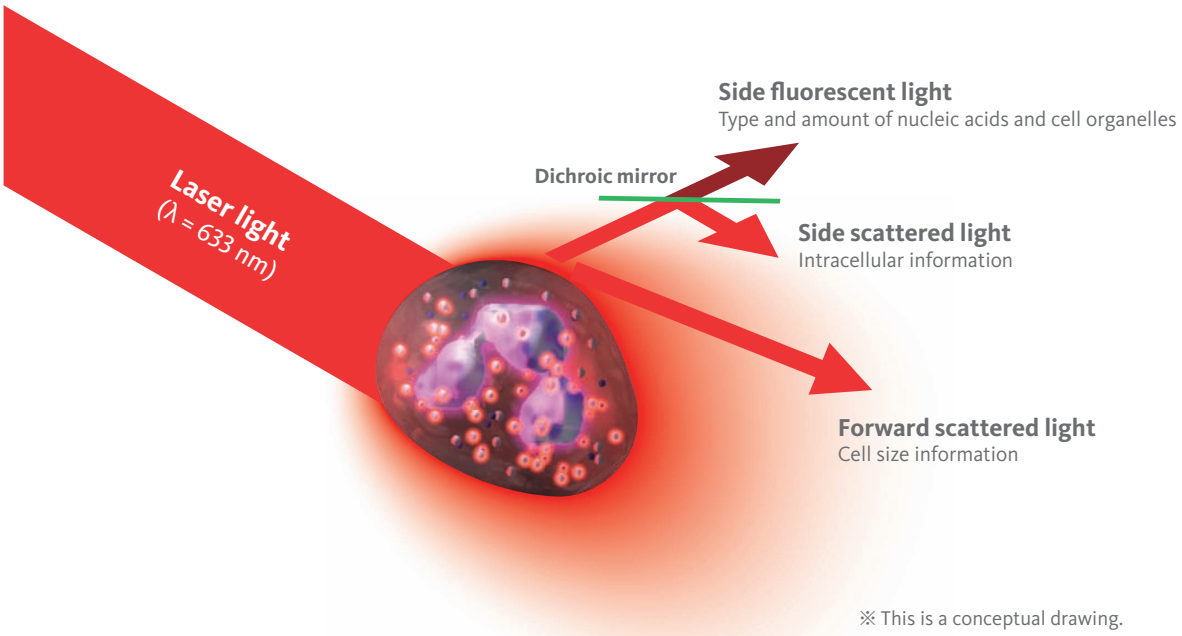
(The body fluid analysis can only be performed if the instrument offers the body fluid mode.)

Measurement principle of flow cytometry with a semiconductor laser

Cell analysis based on the principle of flow cytometry

The flow cytometry using a semiconductor laser counts and classifies cells by irradiating them with a 633 nm laser beam and analyzing their forward scattered light (FSC), side scattered light (SSC) and side fluorescent light (SFL). The intensity of the two types of scattered light (FSC and SSC) reflects cell surface structure, particle shape, nucleus form, refractive index and reflectivity of the cells. In general, the FSC signal is stronger for larger cells, and the SSC signal becomes stronger as the intracellular structures become more complex. The intensity of the side fluorescent light mainly reflects the type and amount of nucleic acids and cell organelles. These three signals are used to differentiate and count white blood cells, nucleated red blood cells, reticulocytes, and platelets, and to detect abnormal cells and immature cells with the help of unique digital technology and algorithms.





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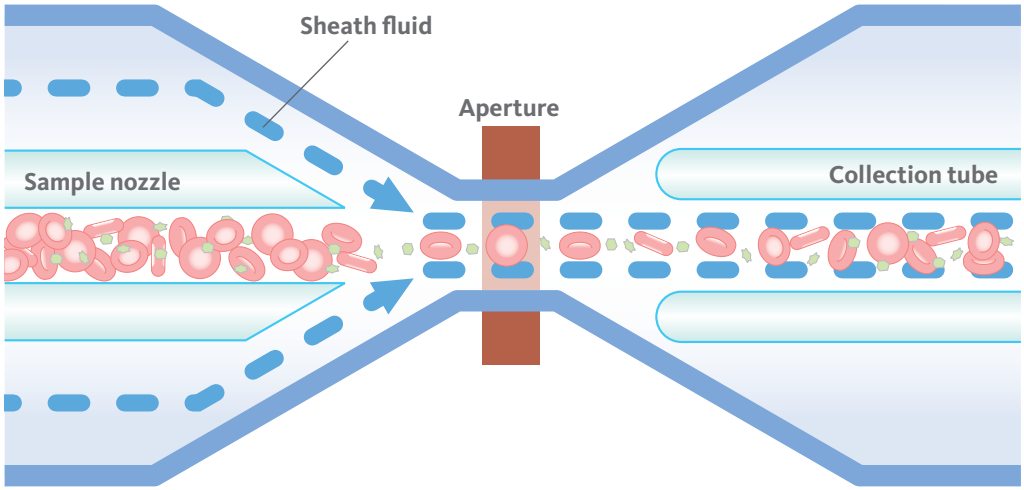
Measurement principle of sheath flow DC detection

RBC/PLT channel

Reagent CELLPACK DCL/DST

The RBC/PLT channel counts red blood cells and platelets using the sheath flow DC (direct current) detection method. A diluted sample is ejected from the nozzle tip and blood cells pass through the specified path at the center of the aperture enclosed in the sheath fluid. As each blood cell passes through the center of the aperture, blood cell volume information is accurately reflected in the pulse. The cell signals are sensitively captured because of innovations in the unique digital waveform processing technology.



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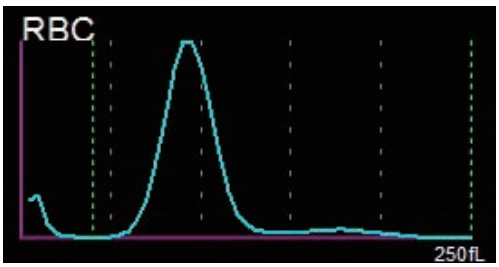
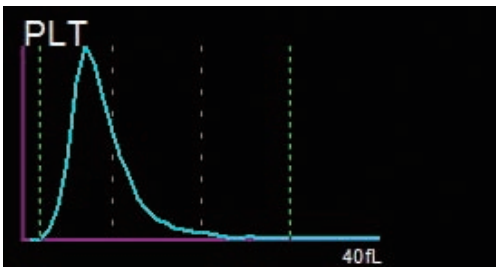
RBC histogram



PLT histogram



Measurement principle of the SLS-hemoglobin method

HGB channel

Reagent CELLPACK DCL/DST, SULFOLYSER

The SLS-hemoglobin method uses sodium lauryl sulfate (SLS) for measuring the hemoglobin concentration. The reaction mechanism of the SLS-hemoglobin method is considered to be as follows:

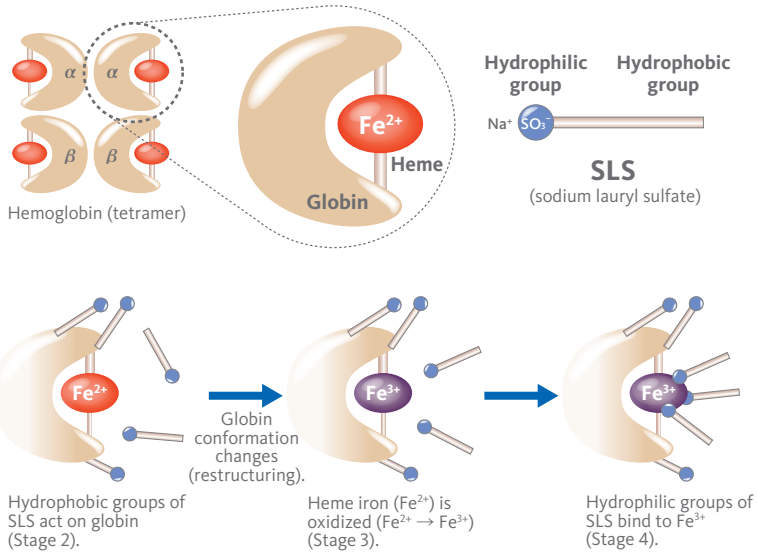
① Stage 1 (hemolytic reaction between SLS and the red blood cell membrane)
SLS binds to the red blood cell membrane mainly by ionic bonding and partly by hydrophobic bonding. This leads to the solubilization of phospholipids on the red blood cell membrane and causes the leakage of hemoglobin from the inside of the red blood cell by modifying the membrane protein structure.

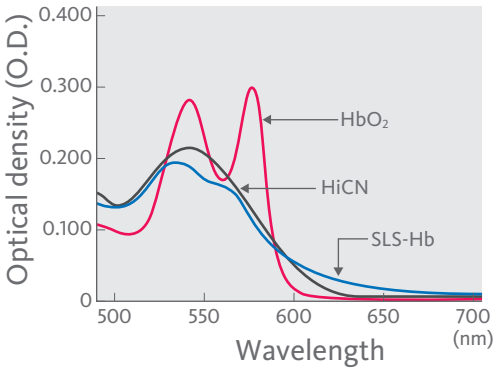
② Stage 2 (change in three-dimensional globin structure by SLS)
The free hemoglobin released by hemolysis undergoes a change in its three-dimensional structure due to the bonding between the hydrophobic group of SLS and globin.

③ Stage 3 (oxidation of heme iron by oxygen)
Concurrently with the change in the three-dimensional structure of globin, the divalent heme iron is easily changed to trivalent iron by the oxygen bound to the heme iron or dissolved oxygen.

④ Stage 4 (Binding of SLS)
The hydrophilic groups of SLS bind to the trivalent heme iron to form stable SLS-hemoglobin. It has been confirmed that the reactions up to this point are completed within 10 seconds when SULFOLYSER is used.

SLS-hemoglobin shows an absorption curve with the maximum peak at wavelength 535 nm and a shoulder peak at 560 nm. The analyzer irradiates light of 555 nm wavelength and measures the absorption.





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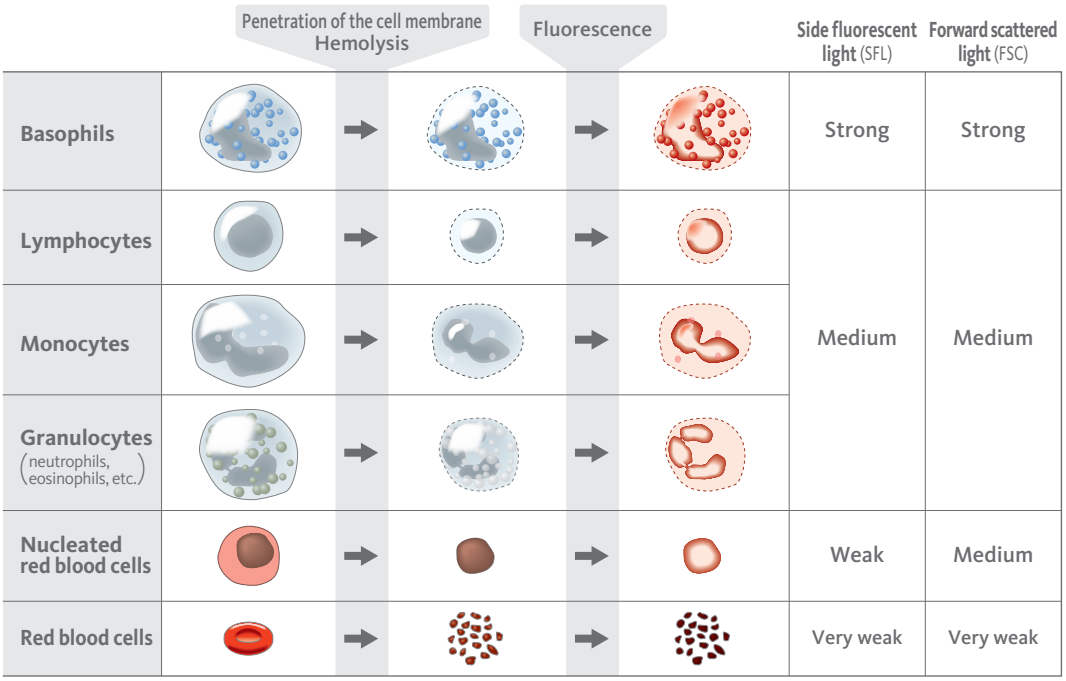
Reagent reactions

WNR channel

Reagent Lysercell WNR, Fluorocell WNR

The WNR channel counts white blood cells and performs a differential counting of basophils and nucleated red blood cells. While causing hemolysis of red blood cells by the action of the surfactant within it, Lysercell WNR penetrates the cell membrane of white blood cells. This causes changes of the external shape and internal structure depending on the cell characteristics of each white blood cell. This channel differentiates basophils from other white blood cells and counts them by capturing these morphological differences based on changes in light scatter (FSC and SSC).
Fluorocell WNR fluorescently stains nucleic acids and cell organelles of white blood cells and nucleated red blood cells. With Lysercell WNR, the stained parts tend to be better preserved and show a stronger fluorescence in white blood cells than in nucleated red blood cells. The WNR channel uses these fluorescence differences to differentiate nucleated red blood cells from white blood cells and thus enables a separate count to be provided for each.



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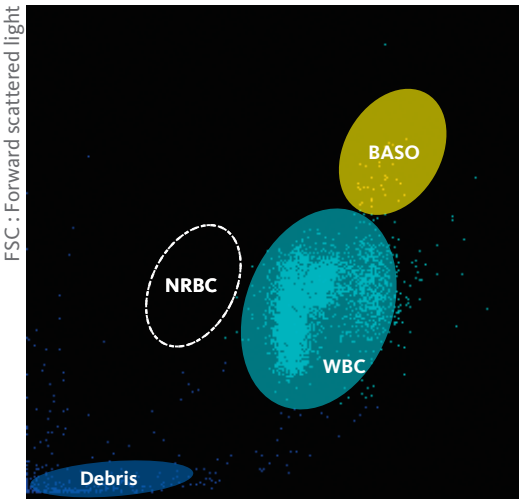
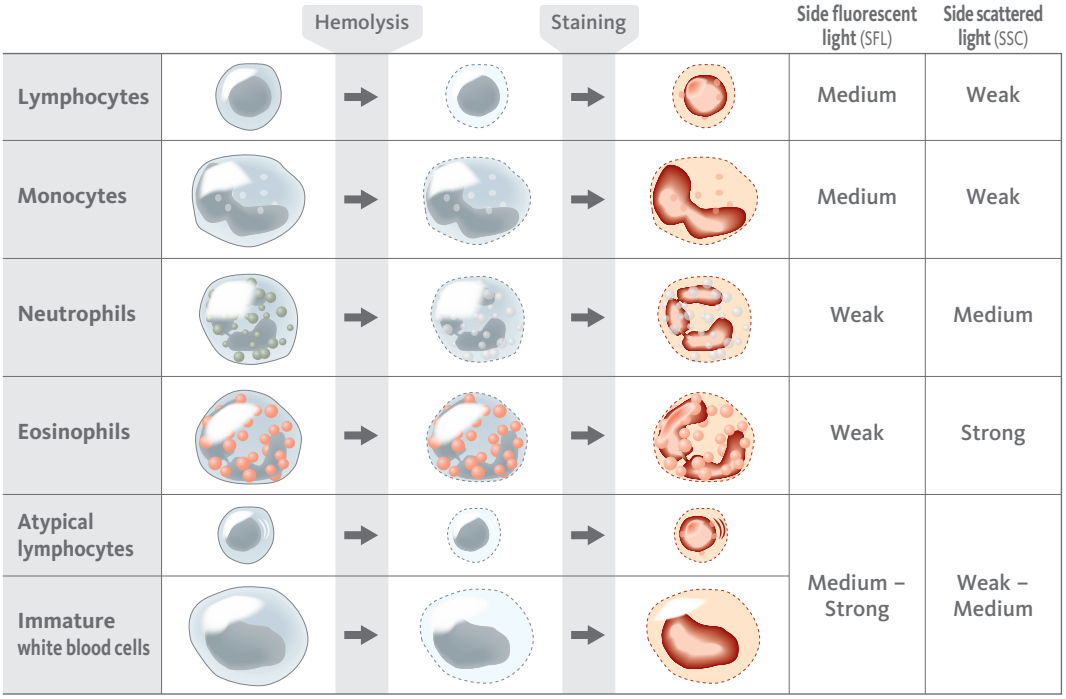
WNR scattergram



WDF channel

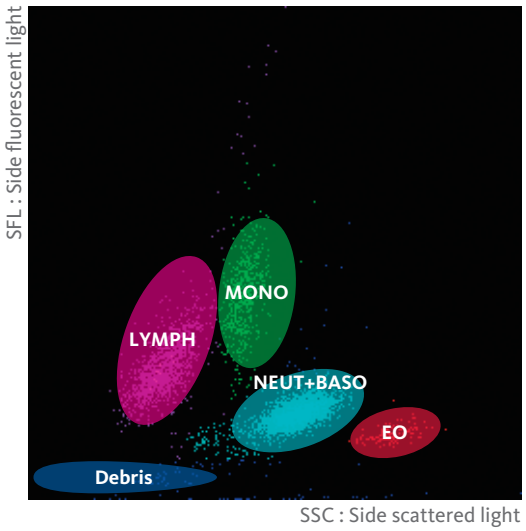
Reagent Lysercell WDF, Fluorocell WDF

The WDF channel differentiates and counts neutrophils, lymphocytes, monocytes and eosinophils and detects abnormal cells such as immature white blood cells and atypical lymphocytes. Surfactants in Lysercell WDF cause the hemolysis and dissolution of red blood cells and platelets and penetrate the cell membranes of white blood cells. The degree of impact and hence change in cell morphology depends on the individual characteristics of each type of white blood cell. These differences are distinguished using side scattered light. Then the fluorescent dye in Fluorocell WDF enters the cells and stains the nucleic acids and cell organelles. The intensity of fluorescence varies among different types of white blood cells, depending on the type and amount of nucleic acids and cell organelles. It is possible to differentiate and count various cells and flag abnormal cells through the cluster analysis of differences in scattered light and fluorescence with the proprietary algorithm.



※ This is a conceptual drawing.

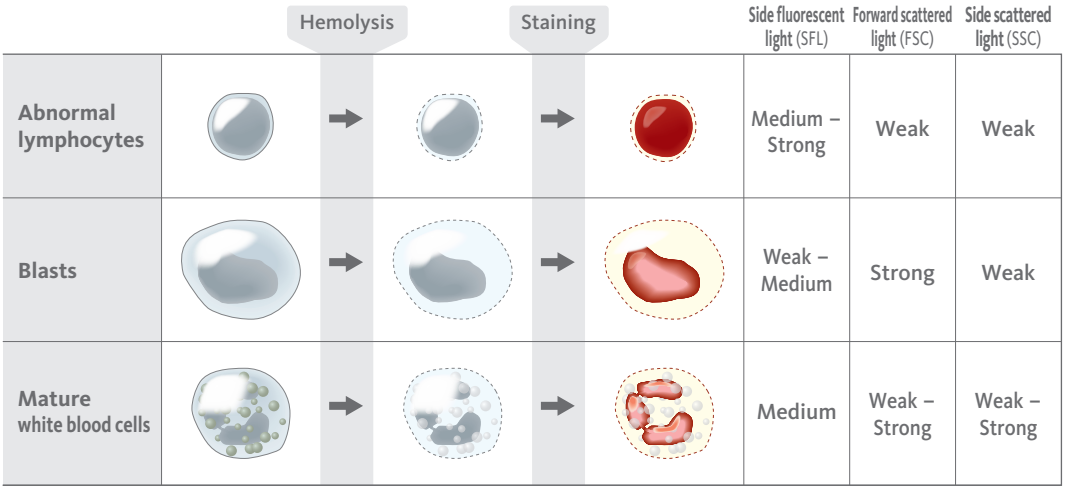
WDF scattergram



WPC channel

Reagent Lysercell WPC, Fluorocell WPC

The WPC channel detects blasts and abnormal cells of the lymphocyte series. Surfactants in Lysercell WPC cause the hemolysis and dissolution of red blood cells and platelets and penetrate the cell membranes of white blood cells. Then the fluorescent dye in Fluorocell WPC enters the cells and stains the nucleic acids and so forth to allow the detection of white blood cells and groups of abnormal cells.
Blasts and abnormal lymphocytic cells have variable characteristics depending on the disorder and individual case, and there may be various differences in contrast to normal cells manifesting in their morphology and their reaction with the surfactants in Lysercell WPC and the fluorescent dye in Fluorocell WPC. These differences in reactivity are reflected by the scattered light and fluorescence intensity, and abnormal cells and cell groups are detected with the proprietary algorithm.



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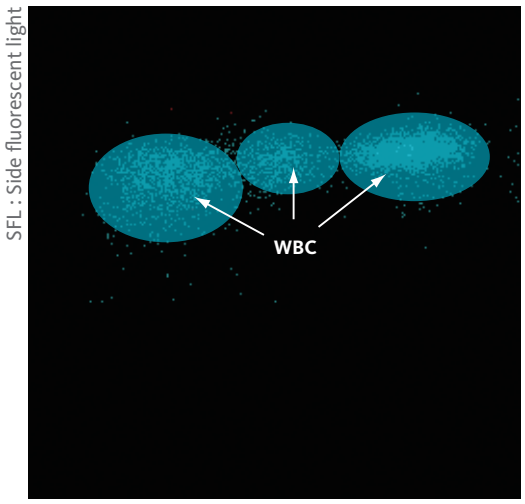
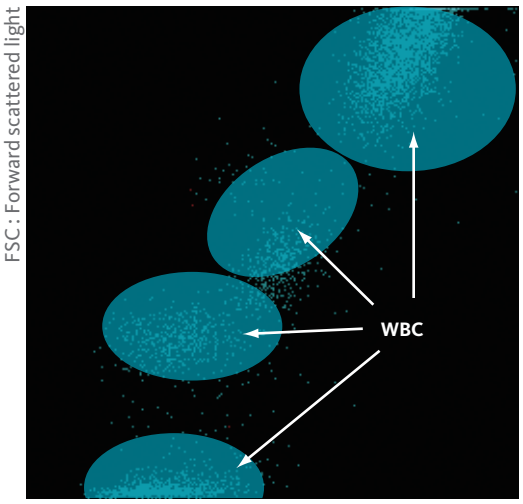
WPC scattergram



WPC (SSC-FSC) scattergram



RET channel

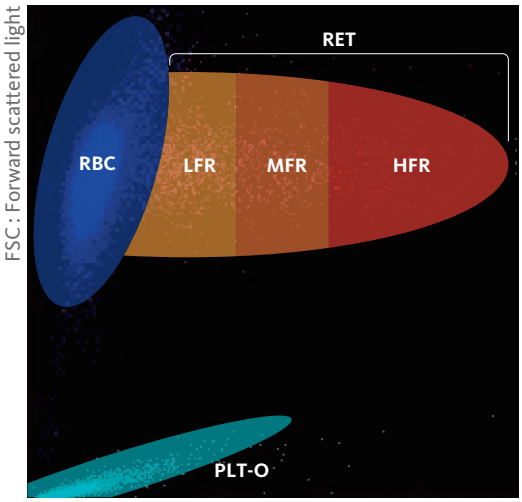
Reagent CELLPACK DFL, Fluorocell RET

In the RET channel, the nucleic acids and so forth in reticulocytes and white blood cells are fluorescently stained with Fluorocell RET fluorescent dye when treated with CELLPACK DFL. These cells are differentiated from mature red blood cells using the difference in fluorescence intensity.

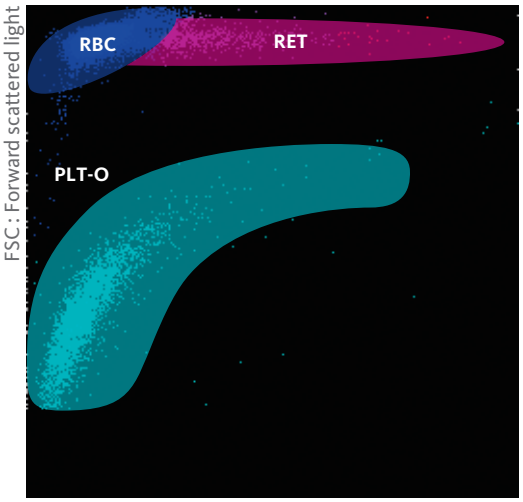
	Staining	Side fluorescent light (SFL)	Forward scattered light (FSC)
White blood cells		Strong	Strong
Reticulocytes		Medium	Strong
Red blood cells		Weak	Strong

※ This is a conceptual drawing.

RET scattergram



PLT-O scattergram



PLT-F channel

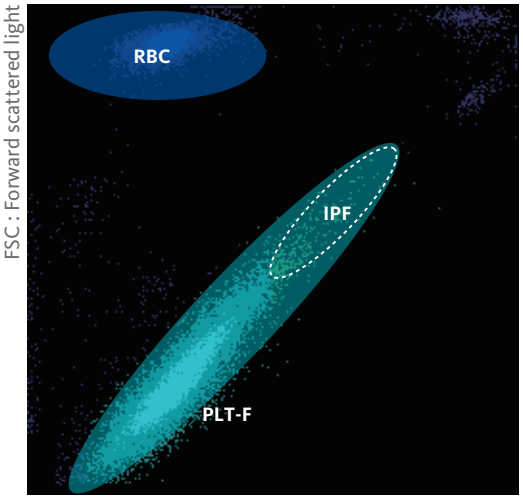
Reagent CELLPACK DFL, Fluorocell PLT

In the PLT-F channel, platelets are specifically stained with the Fluorocell PLT fluorescent dye when treated with CELLPACK DFL. The platelets are counted and additionally, the plots in the area with high fluorescence intensities are separated as the immature platelet fraction (IPF). Platelets are clearly distinguished from other blood cells using the difference in forward scattered light and the fluorescence intensity.

	Staining	**Side fluorescent light** (SFL)	**Forward scattered light** (FSC)
Red blood cells	→	Weak – Medium	Strong
Platelets	→	Weak – Medium	Weak
IPF (immature platelet fraction)	→	Medium – Strong	Medium

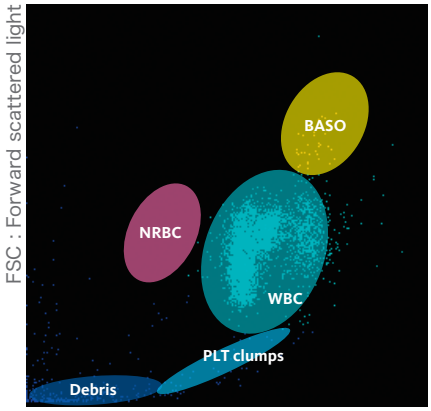
※ This is a conceptual drawing.

PLT-F scattergram

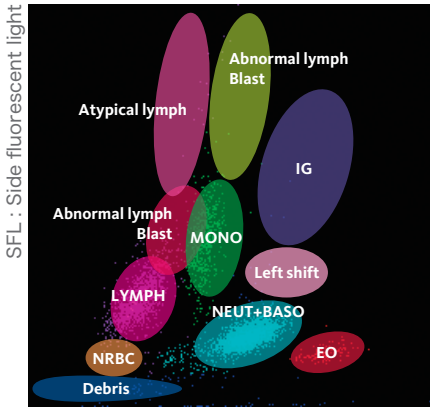


Scattergram patterns that show abnormal cells (whole blood mode)

WNR scattergram

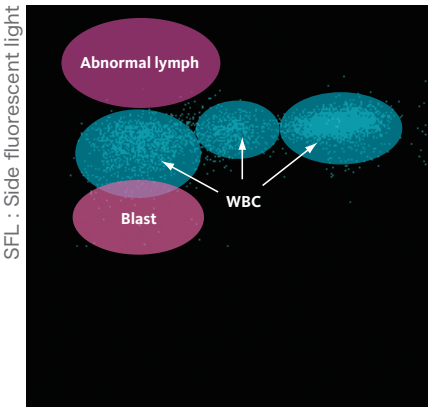


WDF scattergram

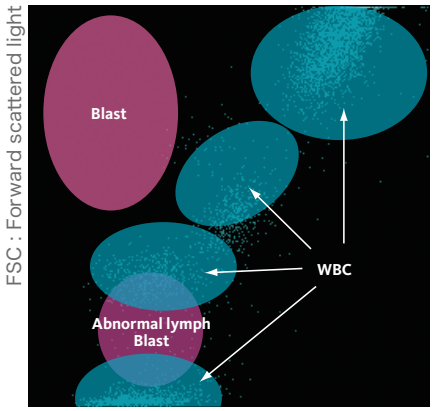


- Nucleated red blood cells
- Blast
- Immature granulocytes
- Left shift (high band cell count)
- Abnormal lymphocytic cells
- Atypical lymphocytes
- Red blood cell fragments
- Aggregated platelets

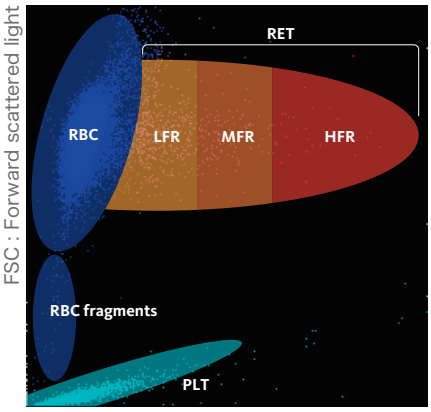
WPC scattergram



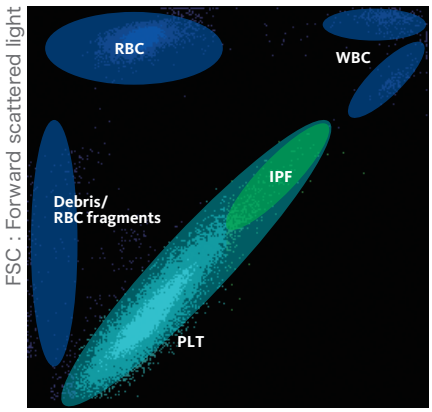
WPC (SSC-FSC) scattergram



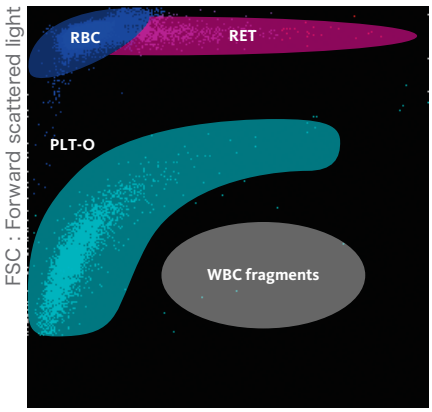
RET scattergram



PLT-F scattergram



PLT-O scattergram



An example of a normal specimen analysis (whole blood mode)

Analysis results (main screen)

CBC

Item	Data	Unit	LL	UL
WBC	5.36	10^9/L		
RBC	4.28	10^12/L		
HGB	126	g/L		
HCT	0.397	L/L		
MCV	92.8	fL		
MCH	29.4	pg		
MCHC	317	g/L		
PLT &F	349	10^9/L		
RDW-SD	46.5	fL		
RDW-CV	13.9	%		
PDW	9.1	fL		
MPV	9.1	fL		
P-LCR	16.7	%		
PCT	0.0030	L/L		
NRBC#	0.00	10^9/L		
NRBC%	0.0	/100WBC		

DIFF

Item	Data	Unit	LL	UL
NEUT#	3.02	10^9/L		
LYMPH#	1.89	10^9/L		
MONO#	0.32	10^9/L		
EO#	0.09	10^9/L		
BASO#	0.04	10^9/L		
NEUT%	56.3	%		
LYMPH%	35.3	%		
MONO%	6.0	%		
EO%	1.7	%		
BASO%	0.7	%		
IG#	0.02	10^9/L		
IG%	0.4	%		

WBC Flag(s)

RBC Flag(s)

PLT Flag(s)

RET

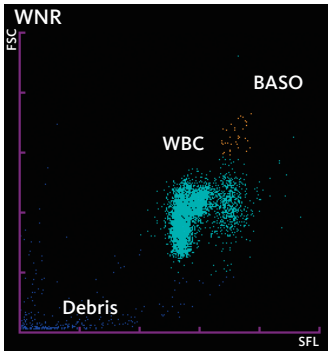
Item	Data	Unit	LL	UL
RET%	2.00	%		
RET#	85.6	10^9/L		
IRF	11.0	%		
LFR	89.0	%		
MFR	9.9	%		
HFR	1.1	%		
RET-He	32.2	pg		

PLT-F

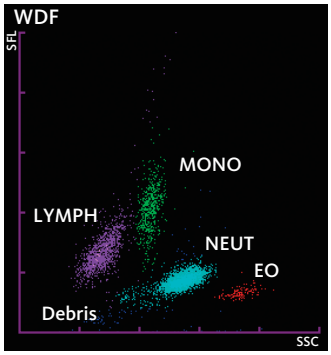
Item	Data	Unit	LL	UL
IPF	1.1	%		

Measured parameters: Numerical data for a total of 36 parameters are displayed.
Research parameters: The measured values of research parameters are indicated with a gray background on the data browser screen.
Flag(s): IP messages concerning WBC, RBC and PLT are displayed.

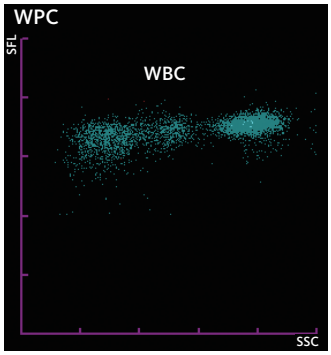
Scattergram



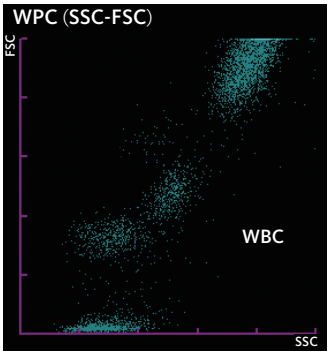
WNR scattergram



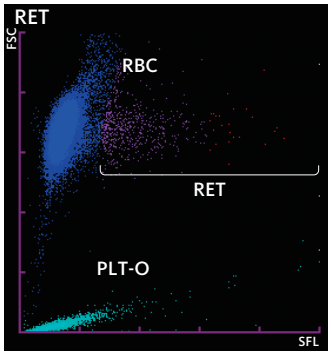
WDF scattergram



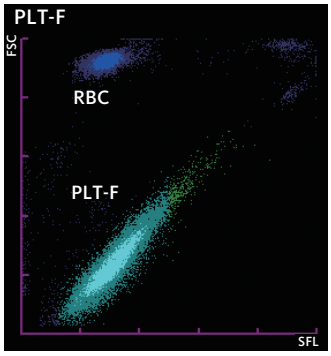
WPC scattergram



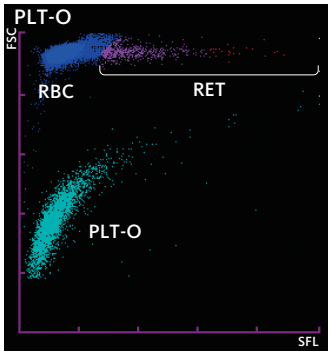
WPC (SSC-FSC) scattergram



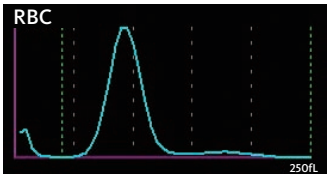
RET scattergram



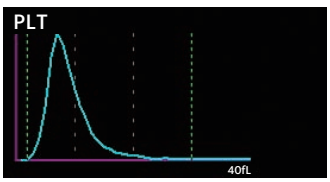
PLT-F scattergram



PLT-O scattergram



RBC histogram



PLT histogram

An example of a body fluid specimen analysis (body fluid mode)

Analysis results (BF research screen)

WBC

Item	Data	Unit
WBC-BF	0,945	10^3/uL

RBC

Item	Data	Unit
RBC-BF	0,206	10^3/uL

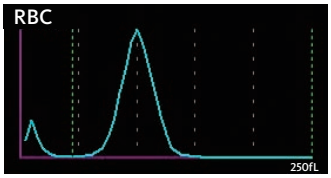
WBC Differential

Item	Data	Unit
PMN#	0,667	10^3/uL
PMN%	70,6	%
MN#	0,278	10^3/uL
MN%	29,4	%

Research Parameter

Item	Data	Unit
TC-BF#	0,947	10^3/uL
HF-BF#	0,002	10^3/uL
HF-BF%	0,0	/100WBC
NE-BF#	0,659	10^3/uL
NE-BF%	69,8	%
LY-BF#	0,019	10^3/uL
LY-BF%	2,0	%
MO-BF#	0,259	10^3/uL
MO-BF%	27,4	%
EO-BF#	0,008	10^3/uL
EO-BF%	0,8	%

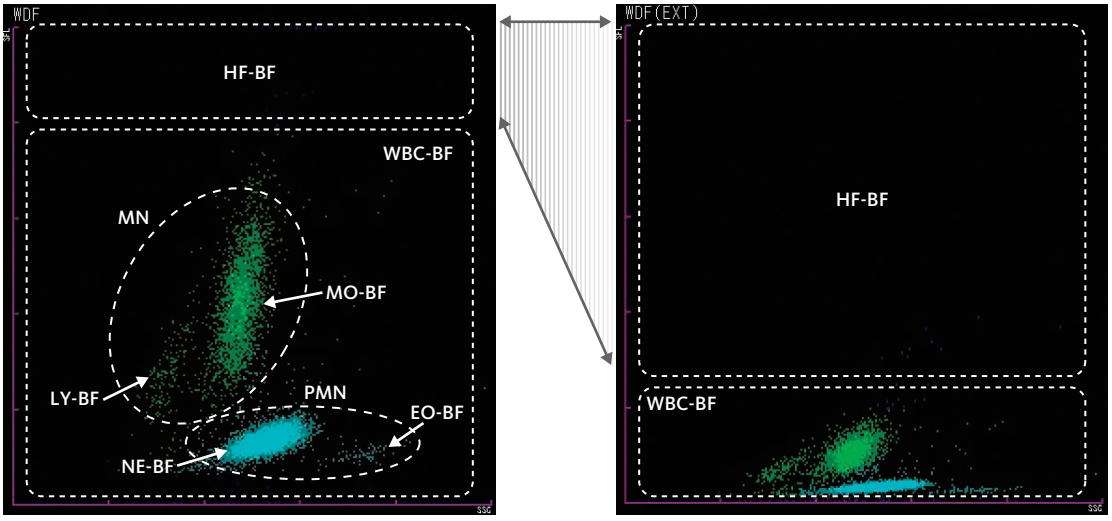
WBC Flag(s)



RBC histogram

Measured parameters: The numerical data for a total of 7 parameters are displayed.
Research parameters: The measured values of research parameters are indicated with a gray background on the data browser screen.
Flag(s): IP messages concerning WBC are displayed.

Scattergram



WDF scattergram

WDF (EXT) scattergram

WBC-BF = MN# + PMN#
TC-BF# = WBC-BF + HF-BF#
MN = LY-BF + MO-BF
PMN = NE-BF + EO-BF

* See pages 4 and 5 for the description of terms.

IP message parameters

	Message	Meaning	Analysis channel	Judgment method/equation
WBC	***Abnormal***			
	WBC Abn Scattergram	Abnormal WBC scattergram	WNR, WDF	Based on clustering in WNR and WDF scattergrams. For body fluid analysis, based on clustering in the WDF scattergram and the HF-BF value.
	Neutropenia	Low neutrophil count	WDF	NEUT# < 1.00 x 10^9/L or NEUT% < 0.0 %
	Neutrophilia	High neutrophil count	WDF	NEUT# > 11.00 x 10^9/L or NEUT% > 100.0 %
	Lymphopenia	Low lymphocyte count	WDF	LYMPH# < 0.80 x 10^9/L or LYMPH%< 0.0 %
	Lymphocytosis	High lymphocyte count	WDF	LYMPH# > 4.00 x 10^9/L or LYMPH% > 100.0 %
	Monocytosis	High monocyte count	WDF	MONO# > 1.00 x 10^9/L or MONO% > 100.0 %
	Eosinophilia	High eosinophil count	WDF	EO# > 0.70 x 10^9/L or EO% > 100.0 %
	Basophilia	High basophil count	WNR	BASO# > 0.20 x 10^9/L or BASO% > 100.0 %
	Leukocytopenia	Low leukocyte count	WNR, WDF	WBC < 2.50 x 10^9/L
	Leukocytosis	High leukocyte count	WNR, WDF	WBC > 18.00 x 10^9/L
	NRBC Present	High nucleated RBC count	WNR	NRBC% > 2.0 %
	IG Present	Increased immature granulocyte	WDF	IG# > 0.10 x 10^9/L or IG% > 100.0 %
	Suspect			
	Blasts/Abn Lympho?	Possibility that blasts are present/Possibility of abnormal lymphocytes	WDF	Judged from the presence of Blasts/AbnLympho on the WDF scattergram.
	Blasts?*1	Possibility that blasts are present	WDF+WPC	Judged from the presence of Blasts on the WDF and WPC scattergrams.
	Abn Lympho?*1	Possibility of abnormal lymphocytes	WDF+WPC	Judged from the presence of AbnLympho on the WDF and WPC scattergrams.
	Left Shift?	Possibility of left shift	WDF	Based on the distribution state of the upper right area of the NEUT in the WDF scattergram.
	Atypical Lympho?	Possibility of atypical lymphocytes	WDF, WDF+WPC	Based on the distribution state of the upper area of the lymphocytes in the WDF scattergram.
RBC	***Abnormal***			
	RBC Abn Distribution	Abnormal RBC distribution	RBC	Arithmetic calculation and numerical comparison
	Dimorphic Population	Multi-peak RBC distribution	RBC	Gap between the high and low points and shape of distribution peak.
	RET Abn Scattergram*2	Abnormal RET scattergram	RET	Clustering in the RET scattergram
	Reticulocytosis*2	Reticulocytosis	RET	RET% > 5.00% or RET# > 200 x 10^9/L
	Anisocytosis	Anisocytosis	RBC	RDW-SD > 65.0 fL or RDW-CV > 20.0%
	Microcytosis	Microcytosis	RBC	MCV < 70.0fL
	Macrocytosis	Macrocytosis	RBC	MCV > 110.0fL
	Hypochromia	Hypochromia	RBC+HGB	MCHC < 290g/L
	Anemia	Anemia	HGB	HGB < 100g/L
	Erythrocytosis	Erythrocytosis	RBC	RBC > 6.50 x 10^{12}/L
	Suspect			
	RBC Agglutination?	Possibility of RBC agglutination	RBC+HGB	Arithmetic calculation and numerical comparison
	Turbidity/HGB Interf?	Possibility of effect on HGB by chylemia	RBC+HGB	Arithmetic calculation and numerical comparison
	Iron Deficiency?	Possibility of iron deficiency	RBC+HGB	Arithmetic calculation and numerical comparison
	HGB Defect?	Possibility of HGB abnormality	RBC	Arithmetic calculation and numerical comparison
	Fragments?	Possibility of fragmented red blood cells	RBC, PLT, RET	Arithmetic calculation and numerical comparison
PLT	***Abnormal***			
	PLT Abn Distribution	Abnormal PLT distribution	PLT	Arithmetic calculation and numerical comparison
	PLT Abn Scattergram*2	Abnormal PLT scattergram	PLT-F	PLT clustering in the PLT scattergram
	Thrombocytopenia	Thrombocytopenia	PLT, RET, PLT-F	PLT# < 60 x 10^9/L
	Thrombocytosis	Thrombocytosis	PLT, RET, PLT-F	PLT# > 600 x 10^9/L
	Suspect			
	PLT Clumps?	Possibility of PLT clumps	WNR, WDF, PLT-F	Judged from the presence of PLT Clumps on the WNR, WDF and PLT-F scattergrams.

*1 WPC+WDF channel only. These messages do not appear with all analyzer types.
*2 These messages do not appear with all analyzer types.

Data display and significance

When an IP message is displayed

When the sample is judged as positive and the following IP message is displayed, it is considered that the reliability of the measured value is low due to the effect of abnormality and an asterisk [*] mark ([----] for some parameters) is displayed on the right side of the data.

	WBC	NRBC #/%	NEUT #/%	LYMPH #/%	MONO #/%	EO #/%	BASO #/%	IG #/%	WBC-BF TC-BF# PMN#/% MN#/%	RBC RET# HCT MCV MCH MCHC	HGB MCH MCHC	RDW-SD	RDW-CV	RET# RET% IRF LFR MFR HFR	PLT	RET-He	PDW MPV P-LCR PCT	IPF
WBC Abn Scattergram																		
Lymph, Mono (WDF)				*	*													
Neut, Eo (WDF)			*			*		*										
Lymph, Neut (WDF)			*	*				*										
Neut, Mono (WDF)			*		*			*										
Lymph, Baso (WDF)			*	*				*										
Lymph, Eo (WDF)				*		*												
Mono, Eo (WDF)					*	*												
Mono, Baso (WDF)			*		*			*										
Ghost, Neut (WDF)	*[*2]	*[*2]	*	*	*	*	*[*2]	*										
Ghost, baso (WDF)	*[*2]	*[*2]	*	*	*	*	*[*2]	*										
Ghost, Lymph (WDF)	*[*2]	*[*2]	*	*	*	*	*[*2]	*										
Ghost, Eo (WDF)	*[*2]	*[*2]	*	*	*	*	*[*2]	*										
Ghost, WBC (BF)*[3] Ghost or other interference with WBC in body fluid analysis									*									
4DIFF, Baso (WNR)			*				*	*										
4DIFF, Nrbc (WNR)	*[*1]	*	*	*	*	*	*	*										
Ghost, 4DIFF (WNR)	*[*1]	*	*	*	*	*	*	*										
Ghost, Nrbc (WNR)	*[*1]	*	*	*	*	*	*	*										
5DIFF data calculation not possible			----	----	----	----	----	----										
IG fraction								*										
HF-BF high value																		
NRBC Present																		
Blasts?[*4]			*	*	*													
Left Shift?			*			*												
Atypical Lympho?			*	*	*													
Blasts/Abn Lympho?			*	*	*													
Abn Lympho?[*4]			*	*	*													
RBC Abn Distribution																		
MP-Flag										*		----	----					
Abnormal RDW-SD										*		----	----					
Other abnormal distribution										*		*	*					
Dimorphic Population												----	----					
RET Abn Scattergram[*4]																		
RET abnormal fraction (Deformation)														*	*[*6]	*		
Other than above (RET zone error)														*		*		
Foreign particles mixed in PLT zone (High impact)															----[*6]			
Foreign particles mixed in PLT zone															*[*6]			
RBC Agglutination?										*								
Turbidity/HGB Interf?											*							
Iron Deficiency?																		
HGB Defect?																		
Fragments?																		
PLT Abn Distribution																		
Abnormal PDW																	----	
Other abnormal distribution																	*	
PLT Abn Scattergram[*4]															*[*7]			*
PLT Clumps?																		
PLT-F not analyzed															*[*5,6]		*	
PLT-F analyzed															*[*7]		*	*

*1 WBC in the WNR channel.
*2 WBC in the WDF channel.
*3 The body fluid analysis can only be performed if the instrument offers the body fluid mode.
*4 These messages do not appear with all analyzer types.
*5 PLT in the RBC/PLT channel.
*6 PLT in the RET channel.
*7 PLT in the PLT-F channel.

Leukocytosis

Neutrophilia with segmented neutrophils

Information from XN-Series

WBC	17.8	10^9/L	+
RBC	5.83	10^{12}/L	+
HGB	176	g/L	+
HCT	0.532	L/L	+
MCV	91.3	fL	
MCH	30.2	pg	
MCHC	331	g/L	
PLT	261	10^9/L	
RDW-SD	45.5	fL	
RDW-CV	13.5	%	
PDW	11.4	fL	
MPV	10.2	fL	
P-LCR	26.6	%	
PCT	0.0027	L/L	
NRBC	0.0	10^9/L	0.0/100 WBC

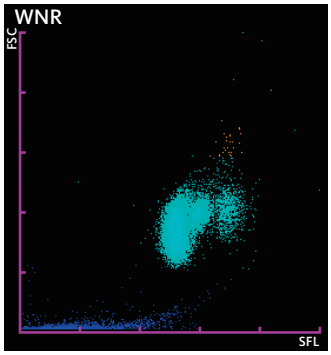
NEUT	12.87	10^9/L	*	72.3 %	*
LYMPH	2.85	10^9/L	*	16.0 %	*
MONO	0.69	10^9/L	*	3.9 %	*
EO	1.36	10^9/L	+	7.6 %	+
BASO	0.03	10^9/L		0.2 %	
IG	0.07	10^9/L		0.4 %	
RET	57.1	10^9/L		0.98 %	
IRF	11.2	%			
LFR	88.8	%			
MFR	10.1	%			
HFR	1.1	%			
RET-He	28.9	pg			
IPF	4.1	10^9/L		1.7 %	

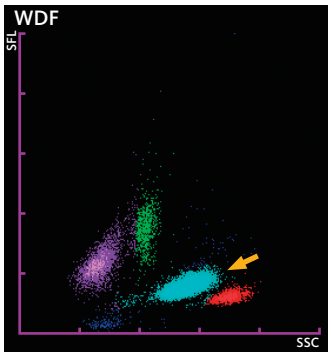
Flags

WBC Flag(s)
Neutrophilia
Eosinophilia

RBC Flag(s)

PLT Flag(s)





Visual differential counts

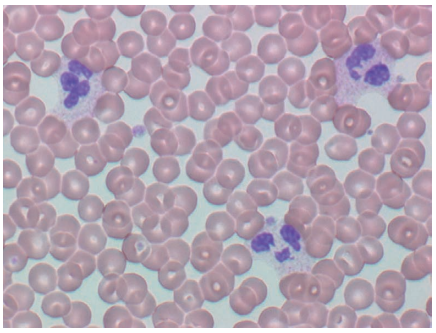
PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	0.0
Segmented N.	71.0
Lymphocytes	16.0
Monocytes	5.0
Basophils	0.5
Eosinophils	7.5
Atypical Lymph	0.0
NRBC	0.0/100 WBC

unit : %

Blood smear (May-Giemsa staining)

PB



×400

Note

A case of neutrophilia with a concentration of segmented neutrophils of 12.87 x 10^9/L is shown. The NEUT cluster (⬆) is indicated in light blue in the WDF scattergram. The differential count of white blood cells matches the visual count.

Neutrophilia with band cells

Information from XN-Series

WBC	7.14	10^9/L	
RBC	4.24	10^{12}/L	
HGB	127	g/L	
HCT	0.415	L/L	
MCV	97.9	fL	
MCH	30.0	pg	
MCHC	306	g/L	–
PLT	201	10^9/L	
RDW-SD	46.7	fL	
RDW-CV	13.2	%	
PDW	9.3	fL	
MPV	8.9	fL	–
P-LCR	15.8	%	
PCT	0.0018	L/L	
NRBC	0.0	10^9/L	0.0/100 WBC

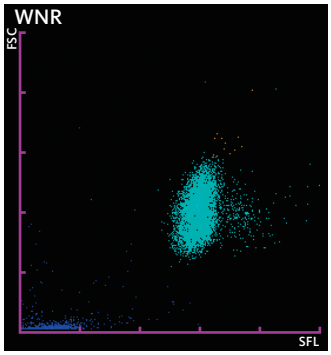
NEUT	6.10	10^9/L	*	85.4 %	*
LYMPH	0.84	10^9/L	*	11.8 %	*
MONO	0.19	10^9/L	*	2.7 %	*
EO	0.00	10^9/L		0.0 %	
BASO	0.01	10^9/L		0.1 %	
IG	0.02	10^9/L		0.3 %	
RET	58.9	10^9/L		1.39 %	
IRF	14.8	%			
LFR	85.2	%			
MFR	13.2	%			
HFR	1.6	%			
RET-He	29.5	pg			
IPF	1.2	10^9/L		0.6 %	

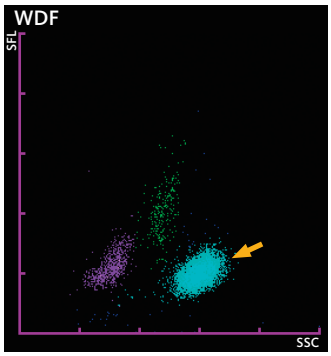
Flags

WBC Flag(s)

RBC Flag(s)

PLT Flag(s)





Visual differential counts

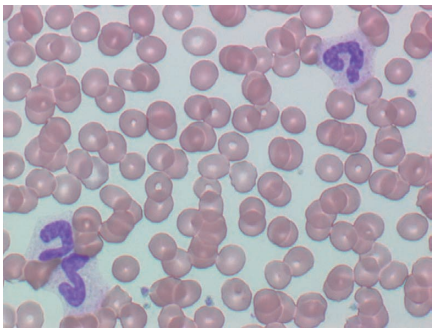
PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	1.0
Stab	34.0
Segmented N.	52.0
Lymphocytes	10.0
Monocytes	3.0
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

unit : %

Blood smear (May-Giemsa staining)

PB



×400

Note

A case of a high band cell count with neutrophils accounting for 85.4% is displayed. Stab neutrophils are counted with 34% in the blood smear. Compared to the case of neutrophilia with segmented neutrophils on the previous page, the NEUT cluster (⬆) in the WDF scattergram spreads towards the higher fluorescence intensity region (upward).

Monocytosis

Information from XN-Series

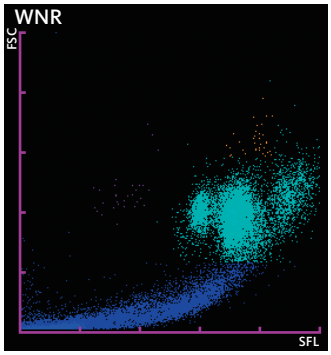
WBC	9.75	10^9/L		NEUT	2.73	10^9/L	* 28.0 % *
RBC	3.59	10^{12}/L		LYMPH	1.55	10^9/L	* 15.9 % *
HGB	96	g/L		MONO	5.38	10^9/L	* 55.2 % *
HCT	0.318	L/L		EO	0.05	10^9/L	0.5 %
MCV	88.6	fL		BASO	0.04	10^9/L	0.4 %
MCH	26.7	pg		IG	0.0	10^9/L	* 0.0 % *
MCHC	302	g/L	–	RET	63.9	10^9/L	1.78 %
PLT	141	10^9/L		IRF	29.6	%	
RDW-SD	50.8	fL		LFR	70.4	%	
RDW-CV	15.9	%		MFR	14.6	%	
PDW	----	fL		HFR	15.0	%	
MPV	----	fL		RET-He	24.6	pg	
P-LCR	----	%		IPF	42.1	10^9/L	27.9 %
PCT	----	L/L					
NRBC	0.04	10^9/L	0.4/100 WBC				

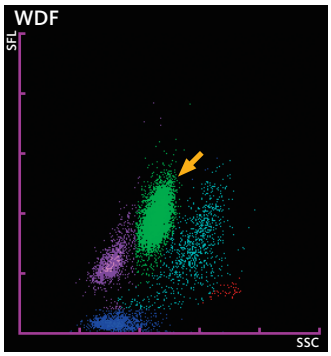
Flags

WBC Flag(s)
WBC Abn Scattergram
Monocytosis

RBC Flag(s)
Anemia
Fragments?

PLT Flag(s)
PLT Abn Distribution





Visual differential counts

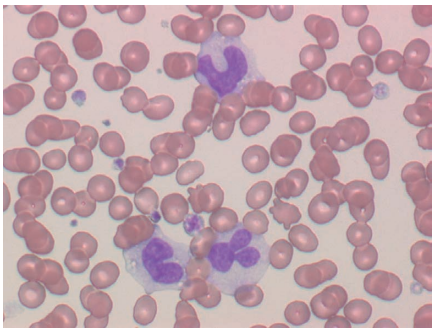
PB

Myeloblast	0.0
Promyelo	0.0
Myelo	1.0
Meta	4.0
Stab	0.0
Segmented N.	9.0
Lymphocytes	16.0
Monocytes	68.0
Basophils	0.5
Eosinophils	1.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

unit : %

Blood smear (May-Giemsa staining)

PB



×400

Note

This page shows a case of monocytosis with a high monocyte count of 55.2%. The MONO cluster (⬆) is indicated in green in the WDF scattergram. The myelocytes and metamyelocytes observed in the blood smear are apparently classified as neutrophils by the XN analyzer, so the result differs from the microscopic count.

Eosinophilia

Information from XN-Series

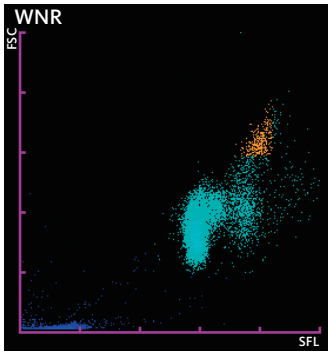
WBC	10.95	10^9/L		NEUT	4.14	10^9/L	37.8 %	
RBC	2.03	10^{12}/L	–	LYMPH	1.48	10^9/L	13.5 %	–
HGB	63	g/L	–	MONO	0.70	10^9/L	6.4 %	
HCT	0.204	L/L	–	EO	4.28	10^9/L	+ 39.1 %	+
MCV	100.5	fL		BASO	0.35	10^9/L	+ 3.2 %	+
MCH	31.0	pg		IG	0.14	10^9/L	1.3 %	
MCHC	309	g/L	–	RET	47.5	10^9/L	2.34 %	
PLT	314	10^9/L		IRF	23.6	%		
RDW-SD	57.0	fL	+	LFR	76.4	%		
RDW-CV	15.5	%		MFR	13.8	%		
PDW	8.0	fL	–	HFR	9.8	%		
MPV	8.8	fL	–	RET-He	30.4	pg		
P-LCR	13.2	%		IPF	2.5	10^9/L	0.7 %	
PCT	0.0028	L/L						
NRBC	0.0	10^9/L	0.0/100 WBC					

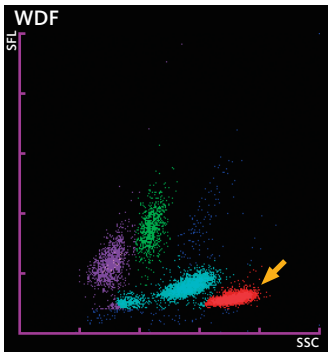
Flags

WBC Flag(s)
Eosinophilia
Basophilia
IG Present

RBC Flag(s)
Anemia

PLT Flag(s)





Visual differential counts

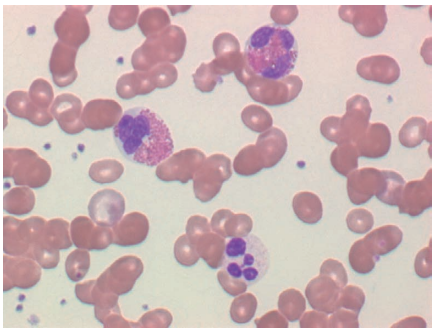
PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	0.0
Segmented N.	35.0
Lymphocytes	11.0
Monocytes	5.0
Basophils	5.0
Eosinophils	44.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

unit : %

Blood smear (May-Giemsa staining)

PB



×400

Note

A case of eosinophilia with 39.1% eosinophils is displayed here. The EO cluster (⬆) is indicated in red in the WDF scattergram. The differential white blood cell count of the analyzer matches the manual count.

Presence of basophils

Information from XN-Series

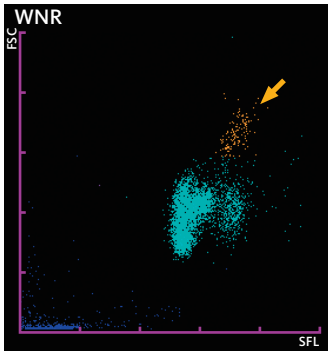
WBC	5.72	10^9/L		NEUT	3.29 10^9/L	57.5%
RBC	4.51	10^{12}/L		LYMPH	1.58 10^9/L	27.6%
HGB	131	g/L		MONO	0.41 10^9/L	7.2%
HCT	0.412	L/L		EO	0.28 10^9/L	4.9%
MCV	91.4	fL		BASO	0.16 10^9/L +	2.8% +
MCH	29.0	pg		IG	0.03 10^9/L	0.5%
MCHC	318	g/L		RET	58.2 10^9/L	1.29%
PLT	295	10^9/L		IRF	13.5 %	
RDW-SD	49.4	fL		LFR	86.5 %	
RDW-CV	15.0	%		MFR	12.1 %	
PDW	9.6	fL		HFR	1.4 %	
MPV	9.4	fL		RET-He	33.6 pg	
P-LCR	19.4	%		IPF	2.3 10^9/L	0.8%
PCT	0.0028	L/L				
NRBC	0.0	10^9/L	0.0/100 WBC			

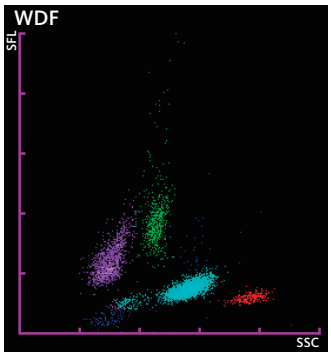
Flags

WBC Flag(s)

RBC Flag(s)

PLT Flag(s)





Visual differential counts

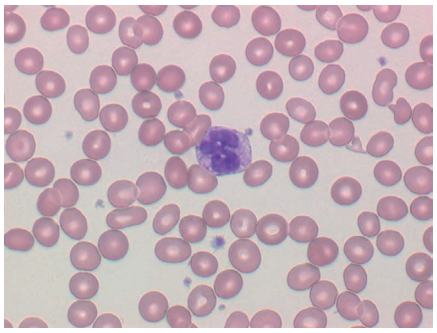
PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	0.0
Segmented N.	70.0
Lymphocytes	18.0
Monocytes	4.0
Basophils	3.0
Eosinophils	5.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

unit : %

Blood smear (May-Giemsa staining)

PB



×400

Note

In this case, basophils appear in the peripheral blood and account for 2.8%. The BASO cluster (⬆) is indicated in orange in the WNR scattergram. The differential white blood cell count matches the manual count.

Bone marrow abnormalities

Acute myeloid leukemia with maturation (AML-M2)

Information from XN-Series

WBC	30.28	10^9/L	+
RBC	2.7	10^{12}/L	
HGB	76	g/L	–
HCT	0.247	L/L	–
MCV	91.5	fL	
MCH	28.1	pg	
MCHC	308	g/L	–
PLT	54	10^9/L	
RDW-SD	50.2	fL	
RDW-CV	16.0	%	
PDW	13.1	fL	
MPV	11.3	fL	
P-LCR	34.9	%	
PCT	0.0006	L/L	–
NRBC	1.34	10^9/L	4.4/100 WBC

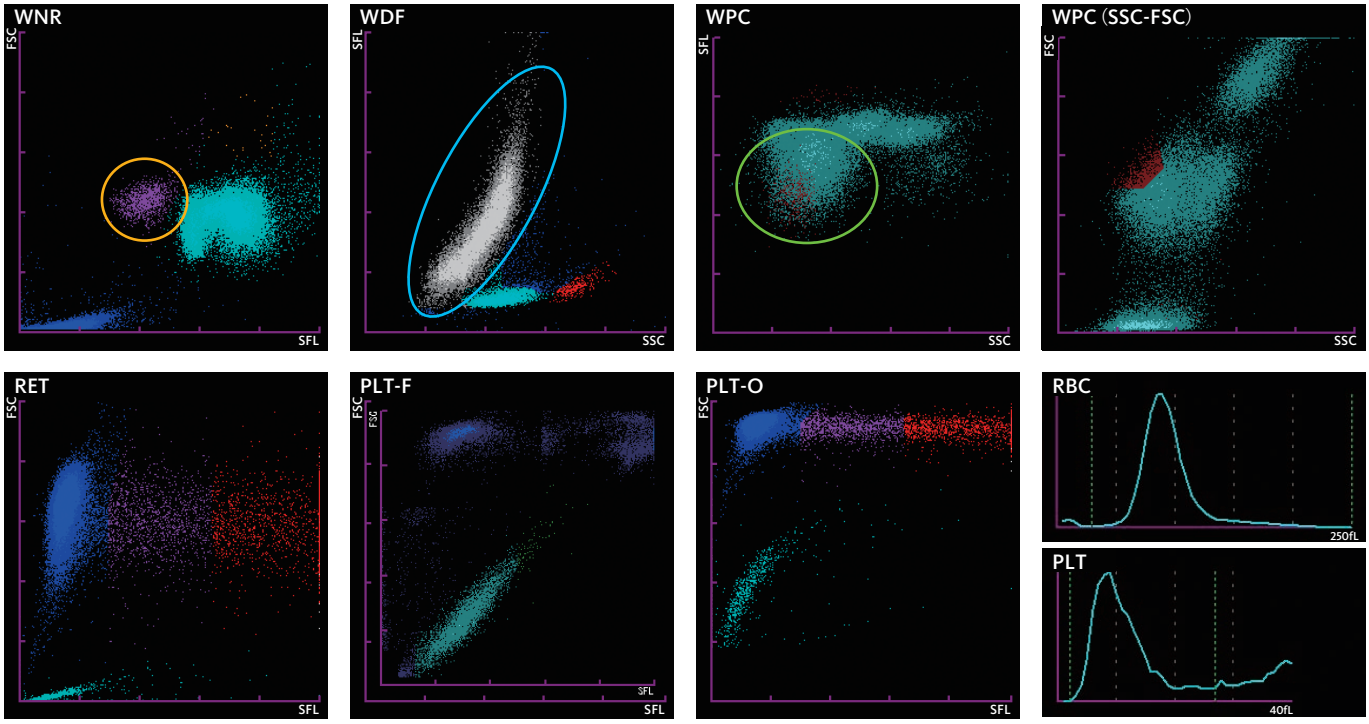
NEUT	8.76	10^9/L	*	28.9 %	*
LYMPH	11.70	10^9/L	*	38.6 %	*
MONO	9.47	10^9/L	*	31.3 %	*
EO	0.32	10^9/L		1.1 %	
BASO	0.03	10^9/L		0.1 %	
IG	0.65	10^9/L		2.1 %	
RET	139.6	10^9/L		5.17 %	
IRF	51.4	%			
LFR	48.6	%			
MFR	24.0	%			
HFR	27.4	%			
RET-He	24.8	pg			
IPF	0.8	10^9/L		1.7 %	

Flags

WBC Flag(s)
- WBC Abn Scattergram
- Lymphocytosis
- Monocytosis
- Leukocytosis
- NRBC Present
- Blasts?

RBC Flag(s)
- Anemia
- Reticulocytosis

PLT Flag(s)
- Thrombocytopenia



Note

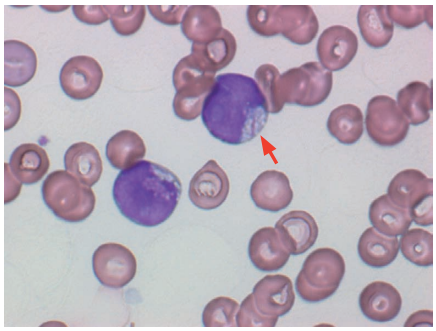
The WNR scattergram shows the presence of NRBC (○) and the results match the visual count. In the WDF scattergram, the LYMPHO and MONO clusters cannot be separated. It is considered that blasts, lymphocytes and monocytes observed in large numbers in the blood smears form one cluster (○). The LYMPH + MONO ratio determined by the XN analyzer roughly agrees with myeloblasts + lymphoblasts + monocytes determined by manual counting. Blasts are assumed to form the ○ cluster in the WPC scattergram, and some cells are detected as abnormal cells in the WPC and WPC (SSC-FSC) scattergram (indicated in red). The findings are in accordance with the appearance of a “Blasts?” flag.

Case history

The patient visited a nearby clinic due to general malaise. Blood tests revealed leukocytosis, anemia and thrombocytopenia.

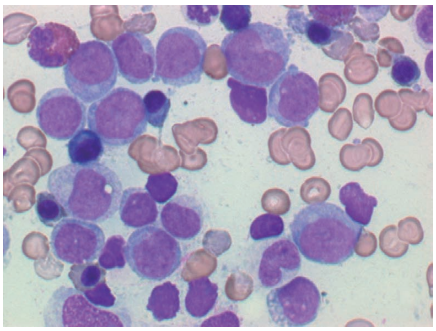
Blood smear (May-Giemsa staining)

PB



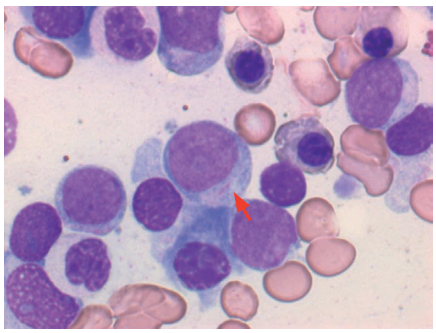
×600

BM



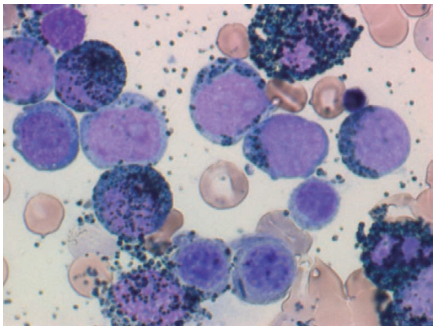
×400

BM



×600

BM (Myeloperoxidase staining)



×600

Note

Leukocytosis, anemia and thrombocytopenia are observed in the peripheral blood. The blasts are of medium size with a low N/C ratio. Their nuclei are round in shape and show some indentations. The nuclear chromatin is fine with large and clear nucleoli. A few blasts with Auer rods (⬆) are seen as well. Vacuoles are observed in the nuclei and the cytoplasm.

The bone marrow shows hyperplasia and an increase in blasts (36.9%). The blasts have a large and basophilic cytoplasm with Auer rods (⬆). Myeloid cells of various maturity stages are observed, reflecting a tendency to differentiate. The neutrophils show few granules. Additionally, the blasts are positive for MPO (myeloperoxidase) staining.

Visual differential counts

PB	
Myeloblast	50.0
Promyelo	0.0
Myelo	1.0
Meta	0.0
Stab	1.0
Segmented N.	20.0
Lymphocytes	16.0
Monocytes	10.0
Basophils	0.0
Eosinophils	2.0
Atypical Lymph	0.0
NRBC	4.0/100 WBC

Other tests

LD (U/L) 341(110-219)

BM	
NCC (×10⁴/μL)	30.2
Megakaryo (/μL)	15
Myeloblast	36.9
Promyelo	2.3
Myelo	6.9
Meta	2.0
Stab	2.3
Segmented N.	6.0
Eosinophils	2.2
Basophils	0.0
Lymphocytes	7.8
Monocytes	4.5
Plasma	1.8
Macrophage	0.3
Megakaryo	0.1

Pro Erythroblast	0.1
Baso Erythroblast	1.6
Poly Erythroblast	25.2
Orth Erythroblast	0.0
M:E ratio	2.2

MPO staining
90% or more of the blasts are positive.

Chromosome analysis

G-band 46,XY, [20]

unit : %

Cell surface antigen expressions (BM)

T-Cell	
CD2	1.0
CD4	2.2
CD5	0.3
CD7	1.3
CD8	0.2

B-Cell	
CD19	1.2

NK-Cell	
CD56	0.2

Myeloid	
CD11b	4.0
CD13	63.7
CD14	3.1
CD33	86.7
CD36	8.5
CD64	1.5
CD117	69.3
MPO	99.0

Other	
CD34	85.5
CD38	98.6
CD41b	0.9
CD61	0.5
Gly-A	0.4
HLA-DR	65.2

CD45 gating

unit : %

Note

The bone marrow cells are positive for the granulocyte markers CD13, CD33, CD117 and MPO (myeloperoxidase).

Acute myeloid leukemia with maturation (AML-M2 cup-like)

Information from XN-Series

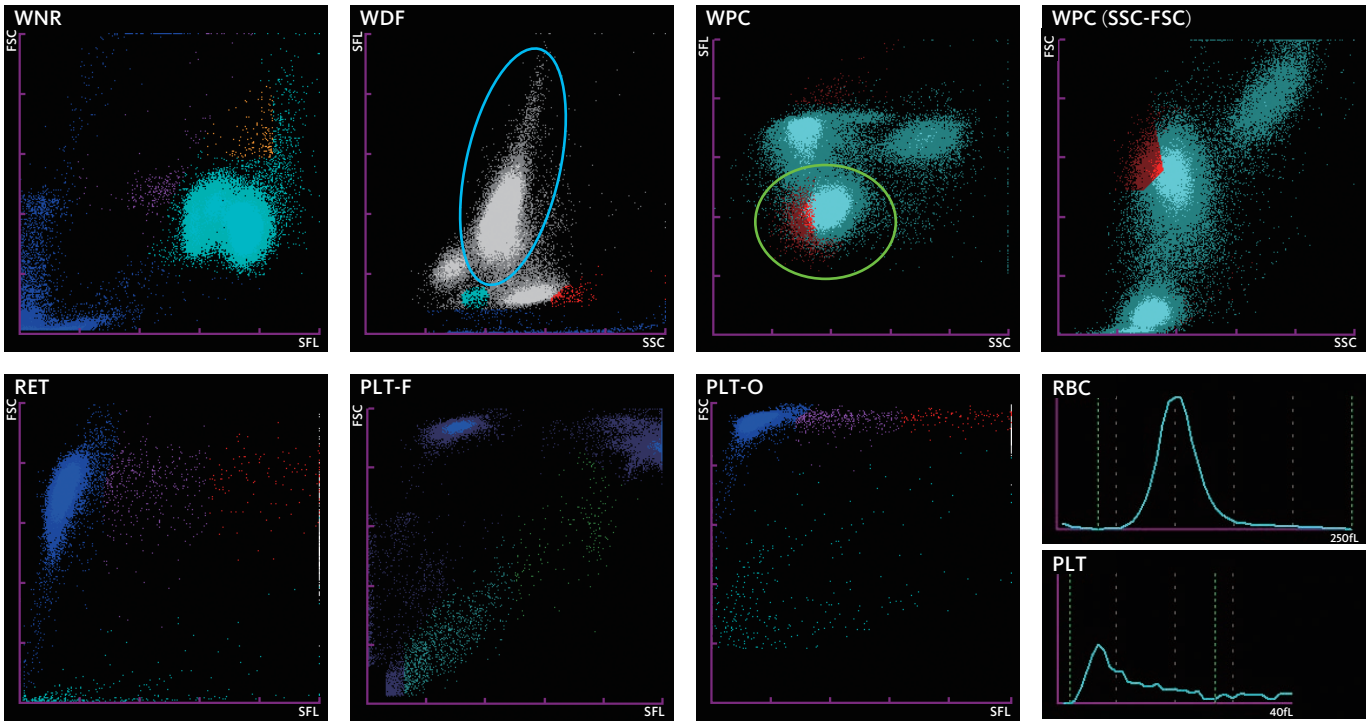
WBC	85.89	10^9/L	+	NEUT	29.28	10^9/L	*	34.0 % *
RBC	2.42	10^{12}/L	–	LYMPH	4.88	10^9/L	*	5.7 % *
HGB	81	g/L		MONO	51.33	10^9/L	*	59.8 % *
HCT	0.248	L/L	–	EO	0.23	10^9/L	*	0.3 % *
MCV	102.5	fL		BASO	0.17	10^9/L	+	0.2 %
MCH	33.5	pg		IG	2.03	10^9/L	*	2.4 % *
MCHC	327	g/L		RET	24.2	10^9/L		1.00 %
PLT	23	10^9/L		IRF	25.9	%		
RDW-SD	55.9	fL	+	LFR	74.1	%		
RDW-CV	15.1	%		MFR	14.0	%		
PDW	17.3	fL	+	HFR	11.9	%		
MPV	11.7	fL		RET-He	33.8	pg		
P-LCR	38.7	%		IPF	1.8	10^9/L		10.6 %
PCT	0.0003	L/L	–					
NRBC	0.3	10^9/L	0.3/100 WBC					

Flags

WBC Flag(s)
- WBC Abn Scattergram
- Neutrophilia
- Lymphocytosis
- Monocytosis
- Leukocytosis
- IG Present
- Blasts?
- Left Shift?

RBC Flag(s)
- RET Abn Scattergram
- Anemia

PLT Flag(s)
- Thrombocytopenia



Note

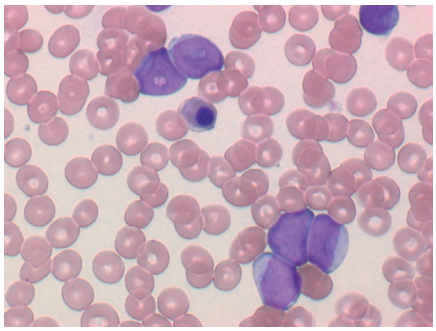
The white blood cell count is markedly high with a high monocyte fraction of 59.8%. While blasts are the main components in the manual count, the WDF scattergram shows a poor separation. It seems that these cells are plotted near the area where normal monocytes appear (○). In the WPC scattergram, most of the blasts are found in the ○ area; some are detected as abnormal cells in the WPC and WPC (SSC-FSC) scattergrams, with the “Blasts?” flag displayed.

Case history

This example shows a case of AML (M2). Remission was first confirmed after chemotherapy, but now blasts are seen in the peripheral blood samples during follow-up.

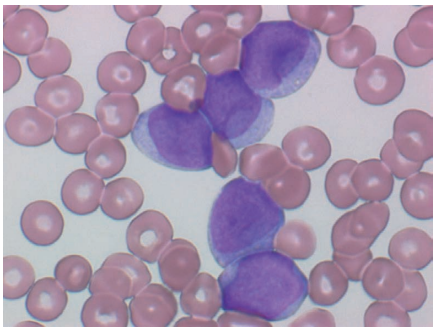
Blood smear (May-Giemsa staining)

PB



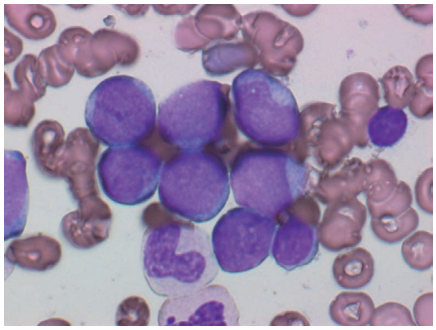
×400

PB



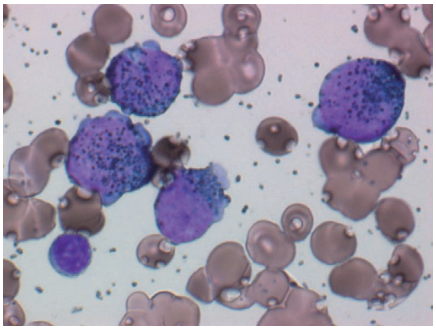
×600

BM



×600

BM (Myeloperoxidase staining)



×600

Note

Leukocytosis, anemia and thrombocytopenia are observed in the peripheral blood. The blast count is markedly increased (82.5%). The blasts are of medium size with a relatively high N/C ratio. The nuclear chromatin is fine, and there are several nucleoli included. The nuclei are circular and some have a cup-like indentation.
The bone marrow shows hyperplasia with an increase in blasts (69.5%). Some blasts show a cup-like indentation on the nucleus. The blasts are also positive for MPO staining.

Visual differential counts

PB	
Myeloblast	82.5
Promyelo	0.0
Myelo	1.5
Meta	0.0
Stab	2.0
Segmented N.	8.5
Lymphocytes	3.0
Monocytes	2.5
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
NRBC	1.0/100 WBC

Other tests

LD (U/L)
1283(110-219)

BM	
NCC (×10⁴/μL)	17.9
Megakaryo (/μL)	<15
Myeloblast	69.5
Promyelo	0.4
Myelo	4.1
Meta	2.1
Stab	2.3
Segmented N.	10.1
Eosinophils	0.4
Basophils	0.0
Lymphocytes	4.8
Monocytes	0.8
Plasma	1.8
Macrophage	0.1
Megakaryo	0.0

Pro Erythroblast	0.0
Baso Erythroblast	0.0
Poly Erythroblast	3.6
Orth Erythroblast	0.0
M:E ratio	24.7

MPO staining
90% or more of the blasts were positive.

Chromosome analysis

G-band 46,XY [20]

unit : %

Cell surface antigen expressions (BM)

T-Cell	
CD2	0.2
CD4	0.3
CD5	0.3
CD7	0.2
CD8	0.4

B-Cell	
CD19	0.3

NK-Cell	
CD56	94.6

Myeloid	
CD11b	2.0
CD13	99.6
CD14	1.9
CD33	99.8
CD36	2.0
CD64	2.2
CD117	89.0
MPO	99.8

Other	
CD34	0.5
CD38	99.8
CD41b	0.4
CD61	0.6
Gly-A	0.6
HLA-DR	2.0

CD45 gating

unit : %

Note

The bone marrow cells are positive for the granulocyte markers CD13, CD33, CD117 and MPO (myeloperoxidase). Positivity for the NK cell marker CD56 is also observed. The cells are negative for CD34 and HLA-DR.

Acute promyelocytic leukemia with t (15;17)(q22;q21); PML/RARα (AML-M3 APL)

Information from XN-Series

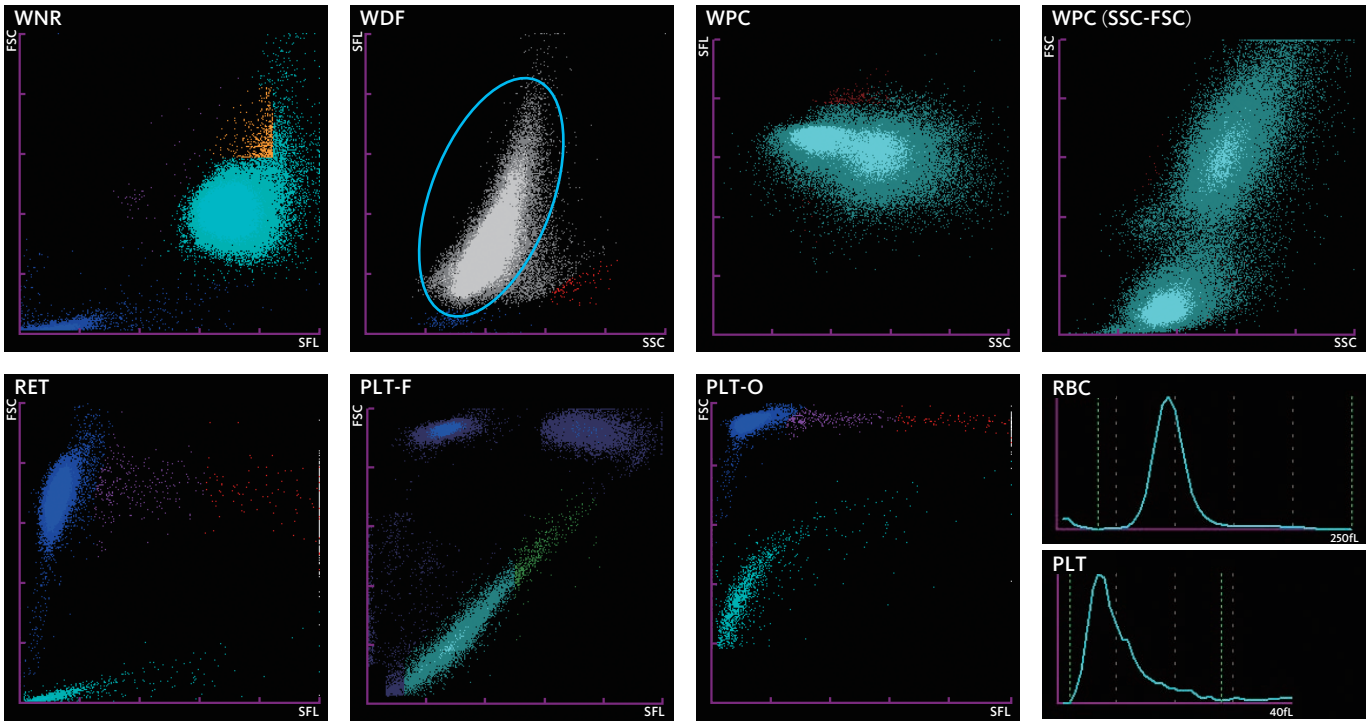
WBC	84.9	10^9/L	+	NEUT	23.72	10^9/L	*	28.0 % *
RBC	2.98	10^{12}/L		LYMPH	26.83	10^9/L	*	31.6 % *
HGB	92	g/L		MONO	33.64	10^9/L	*	39.6 % *
HCT	0.283	L/L		EO	0.10	10^9/L	*	0.1 % *
MCV	95.0	fL		BASO	0.61	10^9/L	+	0.7 %
MCH	30.9	pg		IG	2.63	10^9/L	*	3.1 % *
MCHC	325	g/L		RET	19.7	10^9/L		0.66 %
PLT	87	10^9/L		IRF	32.0	%		
RDW-SD	43.5	fL		LFR	68.0	%		
RDW-CV	12.8	%		MFR	14.6	%		
PDW	11.5	fL		HFR	17.4	%		
MPV	10.3	fL		RET-He	33.4	pg		
P-LCR	28.0	%		IPF	4.8	10^9/L		4.9 %
PCT	0.0009	L/L	–					
NRBC	0.06	10^9/L	0.1/100 WBC					

Flags

WBC Flag(s)
WBC Abn Scattergram
Neutrophilia
Lymphocytosis
Monocytosis
Basophilia
Leukocytosis
IG Present
Blasts?
Left Shift?

RBC Flag(s)
Anemia

PLT Flag(s)



Note

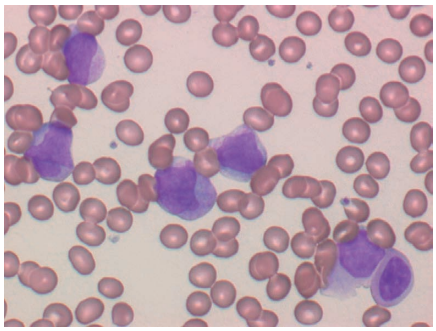
The white blood cell count is markedly high and the WDF scattergram shows a poor separation of cell clusters. The ○ cluster seems like one cell population, and it is assumed that promyelocytes which are observed in large numbers in the blood smear are plotted in this area. The WPC scattergram shows an abnormal pattern, indicating the presence of abnormal cells.

Case history

The patient visited a clinic because of cold-like symptoms. A blood test revealed an increase in promyelocytes and the patient was referred to our hospital.

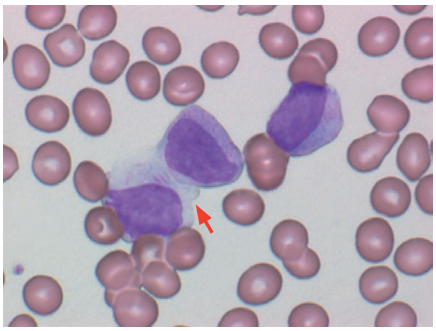
Blood smear (May-Giemsa staining)

PB



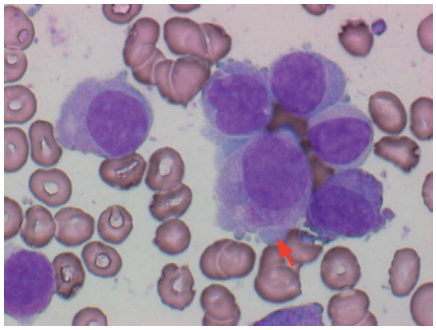
×400

PB



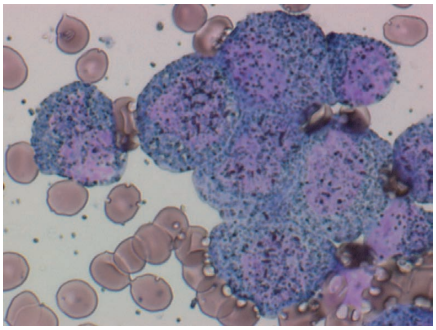
×600

BM



×600

BM (Myeloperoxidase staining)



×600

Note

The peripheral blood shows leukocytosis (82% promyelocytes), anemia and thrombocytopenia. Many of the promyelocytes have an eccentrically located irregular shaped nucleus. Numerous azurophilic granules are seen in the cytoplasm. Auer rods and faggot cells (⬆) are also observed, indicating an increase in abnormal promyelocytes.
The bone marrow is hyperplastic with an increase in promyelocytes (87.0%). The promyelocytes are highly atypical, having irregular nuclei, etc. Projections are seen on cytoplasmic margins. The cells are strongly positive for MPO staining. The t(15;17) (q22;q21) abnormality is seen for 20 cells in a chromosome analysis.

Visual differential counts

PB	
Myeloblast	2.0
Promyelo	82.0
Myelo	4.0
Meta	0.0
Stab	0.0
Segmented N.	0.5
Lymphocytes	7.0
Monocytes	4.5
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

Other tests

LD (U/L)
342(110-219)

BM	
NCC (×10⁴/μL)	20.5
Megakaryo (/μL)	<15
Myeloblast	1.4
Promyelo	87.0
Myelo	1.5
Meta	0.0
Stab	0.0
Segmented N.	0.1
Eosinophils	0.0
Basophils	0.0
Lymphocytes	8.3
Monocytes	0.5
Plasma	0.0
Macrophage	0.0
Megakaryo	0.0

Pro Erythroblast	0.0
Baso Erythroblast	0.0
Poly Erythroblast	1.2
Orth Erythroblast	0.0
M:E ratio	75.0

MPO staining
More than 90% of Blast + Pro are positive.

Chromosome analysis

G-band
46,XY,t(15;17)(q22;q21)[20]

unit : %

Cell surface antigen expressions (BM)

T-Cell	
CD2	6.4
CD4	13.7
CD5	2.0
CD7	8.8
CD8	0.7
B-Cell	
CD19	1.4
NK-Cell	
CD56	3.3
Myeloid	
CD11b	8.4
CD13	64.8
CD14	2.5
CD33	75.7
CD36	4.9
CD64	39.4
CD117	7.5

Other	
CD34	3.0
CD38	48.6
CD41b	1.5
CD45	99.9
CD61	1.7
Gly-A	1.9
HLA-DR	3.4

Coagulation test

PT (sec)	21.5
PT%	38
INR	1.9
APTT (sec)	30
D-Dimer (μg/ml)	23.5
total FDP (μg/ml)	211.9

unit : %

Note

The bone marrow cells are positive for the granulocyte markers CD13 and CD33, weakly positive for CD64, and negative for CD34 and HLA-DR.

Acute monoblastic leukemia (AML-M5a)

Information from XN-Series

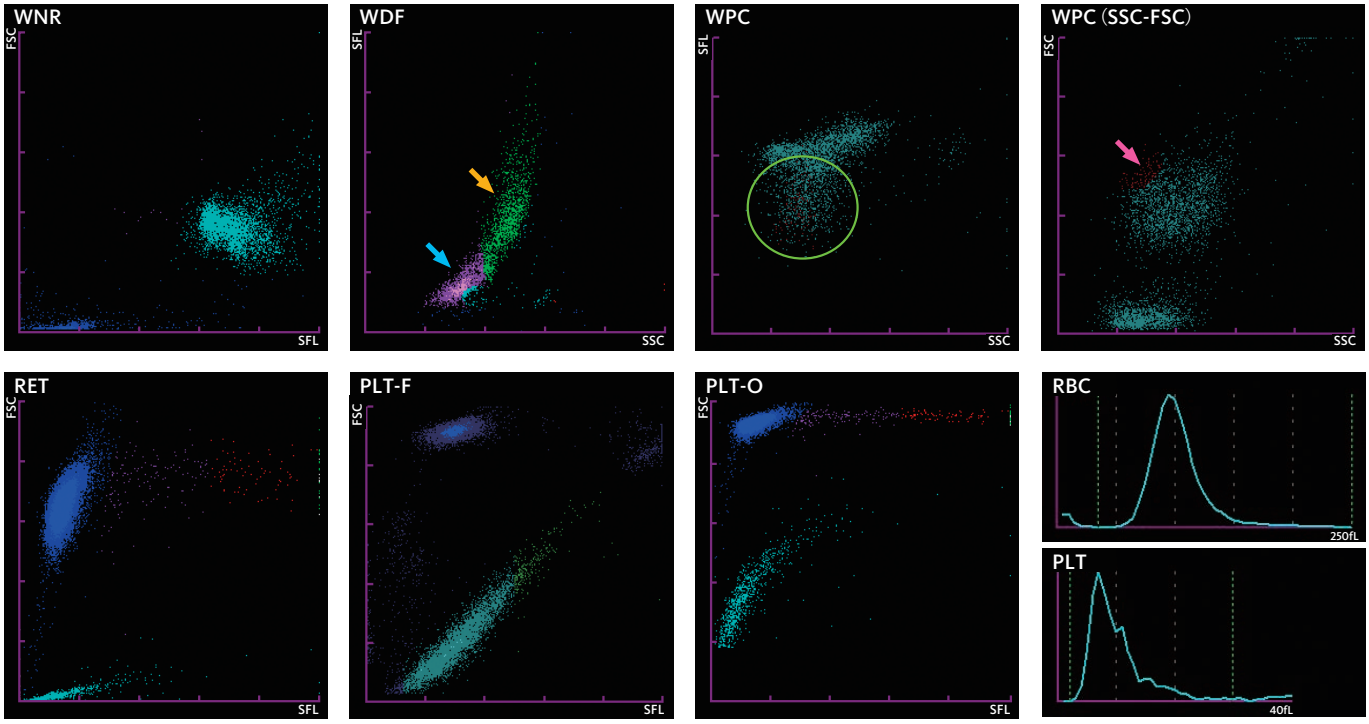
WBC	4.01	10^9/L		NEUT	0.68	10^9/L	*	17.0 % *
RBC	1.99	10^{12}/L	–	LYMPH	2.11	10^9/L	*	52.6 % *
HGB	63	g/L	–	MONO	1.22	10^9/L	*	30.4 % *
HCT	0.198	L/L	–	EO	0.00	10^9/L		0.0 %
MCV	99.5	fL		BASO	0.00	10^9/L		0.0 %
MCH	31.7	pg		IG	0.02	10^9/L		0.5 %
MCHC	318	g/L		RET	10.9	10^9/L		0.55 %
PLT	54	10^9/L		IRF	35.2	%		
RDW-SD	56.8	fL	+	LFR	64.8	%		
RDW-CV	16.2	%	+	MFR	29.5	%		
PDW	9.2	fL		HFR	5.7	%		
MPV	10.1	fL		RET-He	35.6	pg		
P-LCR	24.3	%		IPF	2.3	10^9/L		4.1 %
PCT	0.0005	L/L	–					
NRBC	0.02	10^9/L	0.5/100 WBC					

Flags

WBC Flag(s)
Neutropenia
Monocytosis
Blasts?

RBC Flag(s)
Anemia

PLT Flag(s)
Thrombocytopenia



Note

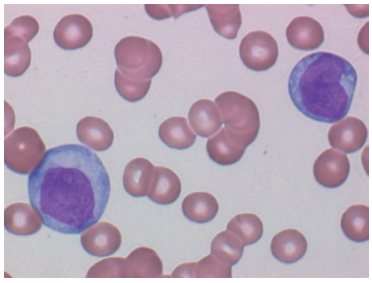
Roughly two cell populations (⬆,⬆) seem to be present in the WDF scattergram. The comparison with the manual count suggests that the ⬆ cluster mainly comprises monoblasts and the ⬆ cluster mainly consists of lymphocytes. In the WPC scattergram, most of the monoblasts are plotted in the ○ area. Some cells are detected as abnormal cells in the WPC and WPC (SSC-FSC) scattergrams (WPC: indicated in red, WPC (SSC-FSC): ⬆). The "Blasts?" flag is also displayed.

Case history

The patient visited the hospital because of cold-like symptoms. The blood tests revealed anemia and thrombocytopenia.

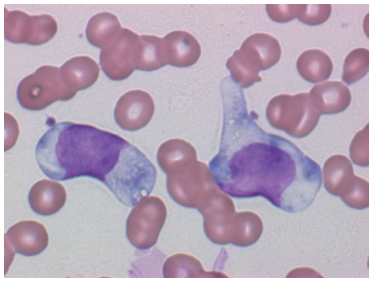
Blood smear (May-Giemsa staining)

PB



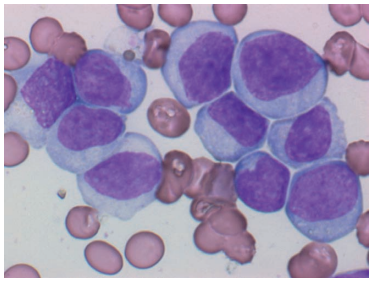
×600

PB



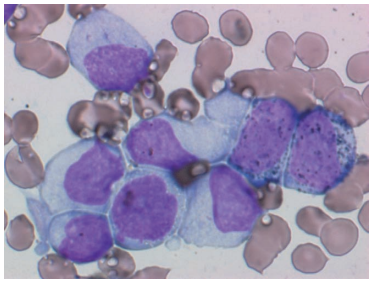
×600

BM



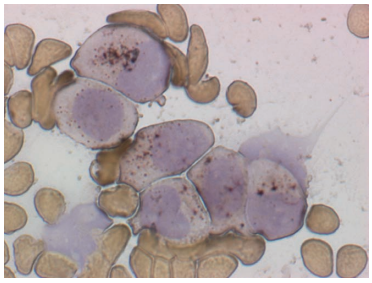
×600

BM (Myeloperoxidase staining)



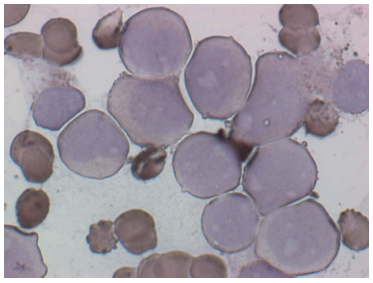
×600

BM (Esterase double staining)



×600

BM (NaF inhibition test)



×600

Note

The peripheral blood shows a normal white blood cell count, anemia and thrombocytopenia. There are 27.5% blasts. Many of the blasts are large in size with a low N/C ratio. The shape of their nuclei varies from oval to indented. Immature monocytes with finer nuclear chromatin than in mature monocytes are also present.
The bone marrow shows euplasia with numerous blasts (85.7%; monoblasts + promonocytes). The blasts are large with voluminous and weakly basophilic cytoplasm. The nuclei are mostly oval with a few indented ones.
37% of the blasts are (weakly) positive for MPO staining, and Esterase double staining is also (weakly) positive for 19% of the cells for the non-specific α-naphthyl butyrate esterase activity. The NaF inhibition test is positive as well.

Visual differential counts

PB	
Monoblast	27.5
Promyelo	0.0
Myelo	1.0
Meta	0.0
Stab	0.0
Segmented N.	3.0
Lymphocytes	35.0
Monocytes	32.5
Basophils	0.0
Eosinophils	0.5
Atypical Lymph	0.0
NRBC	1.0/100 WBC

Other tests

LD (U/L) 671(110-219)

BM	
NCC ($\times 10^4$/μL)	8.7
Megakaryo (/μL)	<15
Monoblast	85.7
Promyelo	0.0
Myelo	0.4
Meta	0.2
Stab	0.0
Segmented N.	0.3
Eosinophils	0.1
Basophils	0.0
Lymphocytes	5.4
Monocytes	0.6
Plasma	4.4
Macrophage	0.0
Megakaryo	0.0

Pro Erythroblast	0.0
Baso Erythroblast	0.1
Poly Erythroblast	2.8
Orth Erythroblast	0.0
M:E ratio	29.9
MPO staining	37 among blasts
EST staining	
α-NB	19 among blasts
ASD chloroacetate	<3 among blasts
NaF inhibition	Present

Chromosome analysis

G-band 46,XY [20]

unit : %

Cell surface antigen expressions (BM)

T-Cell	
CD2	6.1
CD4	30.8
CD5	10.3
CD7	86.3
CD8	2.4
B-Cell	
CD19	3.2
NK-Cell	
CD56	2.9

Myeloid	
CD11b	11.8
CD13	44.6
CD14	6.9
CD33	68.9
CD36	29.8
CD64	13.9
CD117	12.2
MPO	33.2
Other	
CD34	30.8
CD38	98.9
CD41b	2.6
CD61	2.1
Gly-A	0.3
HLA-DR	59.3

unit : %

Note

The bone marrow cells express the granulocyte markers CD13, CD33, CD36 and MPO (myeloperoxidase), and, weakly, CD4 which is present on the surface of monocytic cells. Expression of CD7 is also observed.

Acute erythroid leukemia (AML-M6)

Information from XN-Series

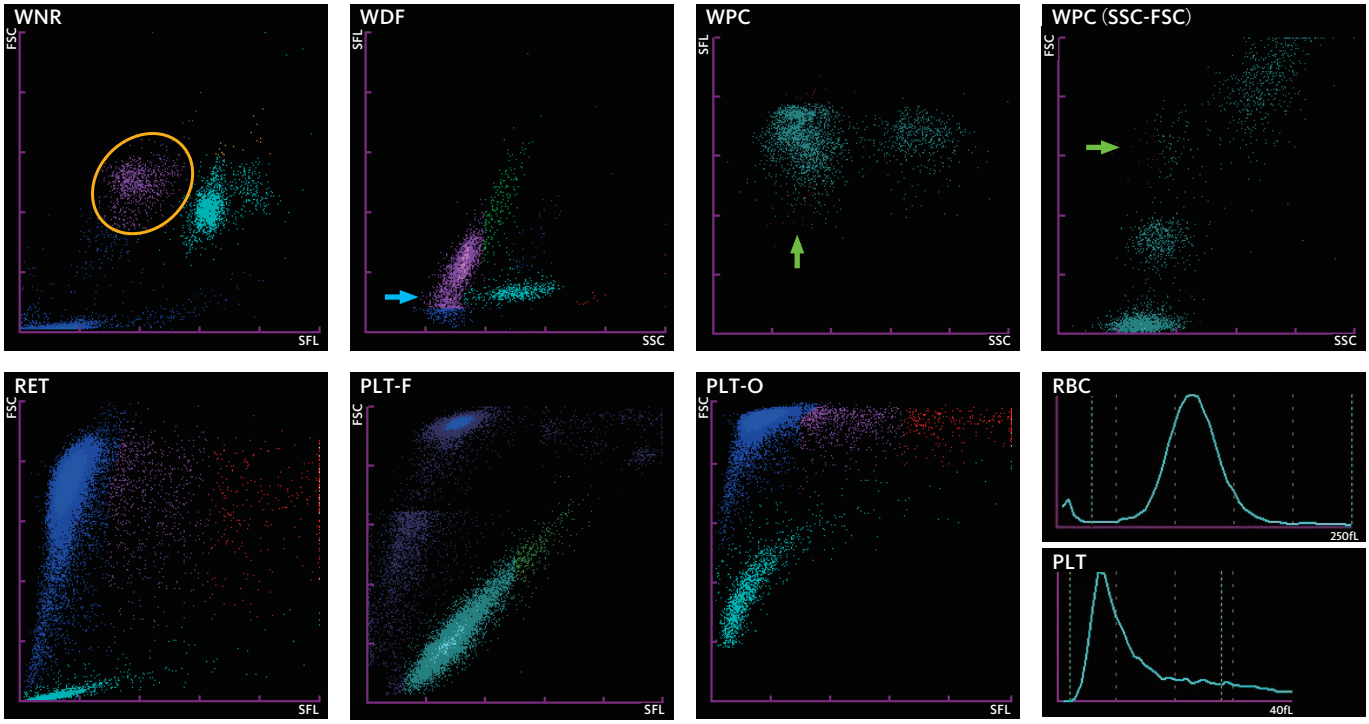
WBC	2.36	10^9/L	–	NEUT	0.74	10^9/L	*	31.4 %	*
RBC	2.49	10^{12}/L	–	LYMPH	1.42	10^9/L	*	60.2 %	*
HGB	90	g/L		MONO	0.17	10^9/L	*	7.2 %	*
HCT	0.281	L/L		EO	0.01	10^9/L		0.4 %	
MCV	112.9	fL	+	BASO	0.02	10^9/L		0.8 %	
MCH	36.1	pg		IG	0.06	10^9/L		2.5 %	
MCHC	320	g/L		RET	46.6	10^9/L		1.87 %	
PLT	118	10^9/L		IRF	27.3	%			
RDW-SD	70.9	fL	+	LFR	72.7	%			
RDW-CV	17.5	%	+	MFR	16.7	%			
PDW	12.8	fL		HFR	10.6	%			
MPV	11.9	fL		RET-He	29.3	pg			
P-LCR	37.3	%		IPF	3.2	10^9/L		3.5 %	
PCT	0.0014	L/L	–						
NRBC	1.01	10^9/L	42.8/100 WBC						

Flags

WBC Flag(s)
- Neutropenia
- Leukocytopenia
- NRBC Present
- Blasts?

RBC Flag(s)
- Anisocytosis
- Macrocytosis
- Anemia
- Fragments?

PLT Flag(s)



Note

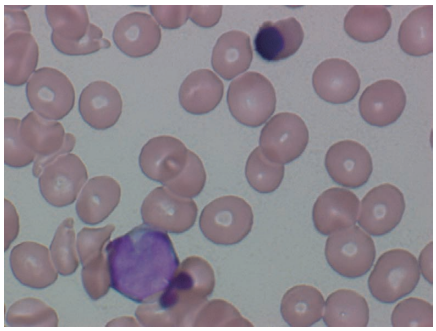
The white blood cell count is low, and the presence of NRBC is confirmed in the WNR scattergram (○). A cluster suspected to be NRBC (⬆) is also seen below the LYMPH cluster in the WDF scattergram. These are classified as lymphocytes in the WDF scattergram, but the value for the lymphocyte ratio is automatically corrected by the NRBC number. In the blood smear, abnormal neutrophil nuclei and hypogranulation can be observed, and the NEUT cluster (indicated in light blue) accordingly extends to the left because of a weaker side scattered light intensity, which reflects intracellular information. It is assumed that the blasts seen in the smear are detected as abnormal cells in the WPC and WPC (SSC-FSC) scattergrams (⬆, indicated in red) with the “Blasts?” flag also displayed.

Case history

The patient visited our outpatient clinic due to loss of appetite and general malaise. A blood test revealed pancytopenia.

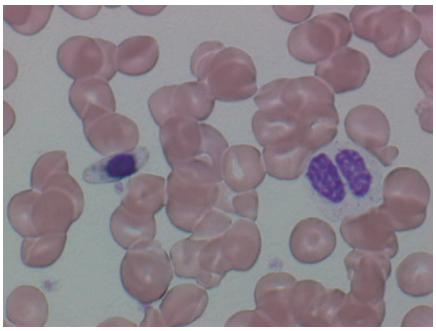
Blood smear (May-Giemsa staining)

PB



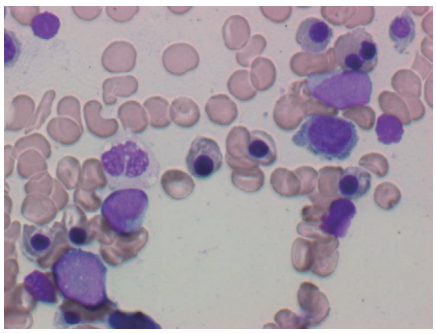
×600

PB



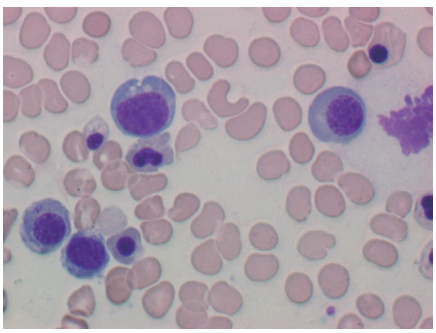
×600

BM



×400

BM



×400

Note

The peripheral blood shows pancytopenia with 10% blasts. The blasts are of medium size with a high N/C ratio. Some of the nuclei are irregularly shaped with fine nuclear chromatin. There are several large nucleoli and many erythroblasts (75/100 WBC). In the neutrophils, Pseudo-Pelger anomaly and hypogranulation are seen.
The bone marrow shows hyperplasia with an M/E ratio of 0.1, which indicates a considerable increase in erythroblasts. There is an increase in orthochromatic erythroblasts, and one can observe megaloblastoid changes – multinucleated erythroblasts with 2 to 3 nuclei as well as fragmentation of nuclei. There are also PAS staining-positive erythroblasts present. Although blasts with 3.6% do not show a marked increase, the ratio of blasts among NEC (non-erythroid cells) is higher than 20%. Pseudo-Pelger anomaly and hypogranulation are seen in the neutrophils. A hyperdiploid abnormality is observed by chromosome analysis.

Visual differential counts

PB	
Myeloblast	10.0
Promyelo	0.0
Myelo	1.0
Meta	0.0
Stab	0.0
Segmented N.	27.0
Lymphocytes	60.0
Monocytes	2.0
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
NRBC	75.0/100 WBC
Megakaryo	1.0/100 WBC

Other tests

LD (U/L) 308(110-219)

BM	
NCC (×10⁴/μL)	26.7
Megakaryo (/μL)	30
Myeloblast	3.6
Promyelo	0.4
Myelo	0.1
Meta	0.8
Stab	0.9
Segmented N.	1.8
Eosinophils	0.5
Basophils	0.0
Lymphocytes	1.9
Monocytes	0.6
Plasma	1.0
Macrophage	0.6
Megakaryo	0.3

Pro Erythroblast	0.5
Baso Erythroblast	1.3
Poly Erythroblast	52.3
Orth Erythroblast	33.4
M:E ratio	0.1
Fe staining	
Type 0	4
Type 1	15
Type 2	80
Type 3	1
PAS staining	positive in NRBC

Chromosome analysis

G-band

54,XY,+1,+3,add(3)(q11.2),+4,+6,+8,+10,+11,+,15,-16,+mar[18]/46,XY[2]

unit : %

Cell surface antigen expressions (BM)

T-Cell	
CD2	4.4
CD4	7.0
CD5	3.3
CD7	5.1
CD8	1.1
B-Cell	
CD19	2.8
NK-Cell	
CD56	2.0

Myeloid	
CD11b	14.2
CD13	89.9
CD14	12.9
CD33	90.4
CD36	17.0
CD64	16.5
CD117	74.9
MPO	29.2
Other	
CD34	87.6
CD38	89.2
CD41b	10.2
CD61	7.3
Gly-A	7.8
HLA-DR	31.4

CD45 gating

unit : %

Note

The bone marrow cells are positive for the granulocyte markers CD13, CD33, CD117 and MPO (myeloperoxidase).

Acute megakaryoblastic leukemia (AML-M7)

Information from XN-Series

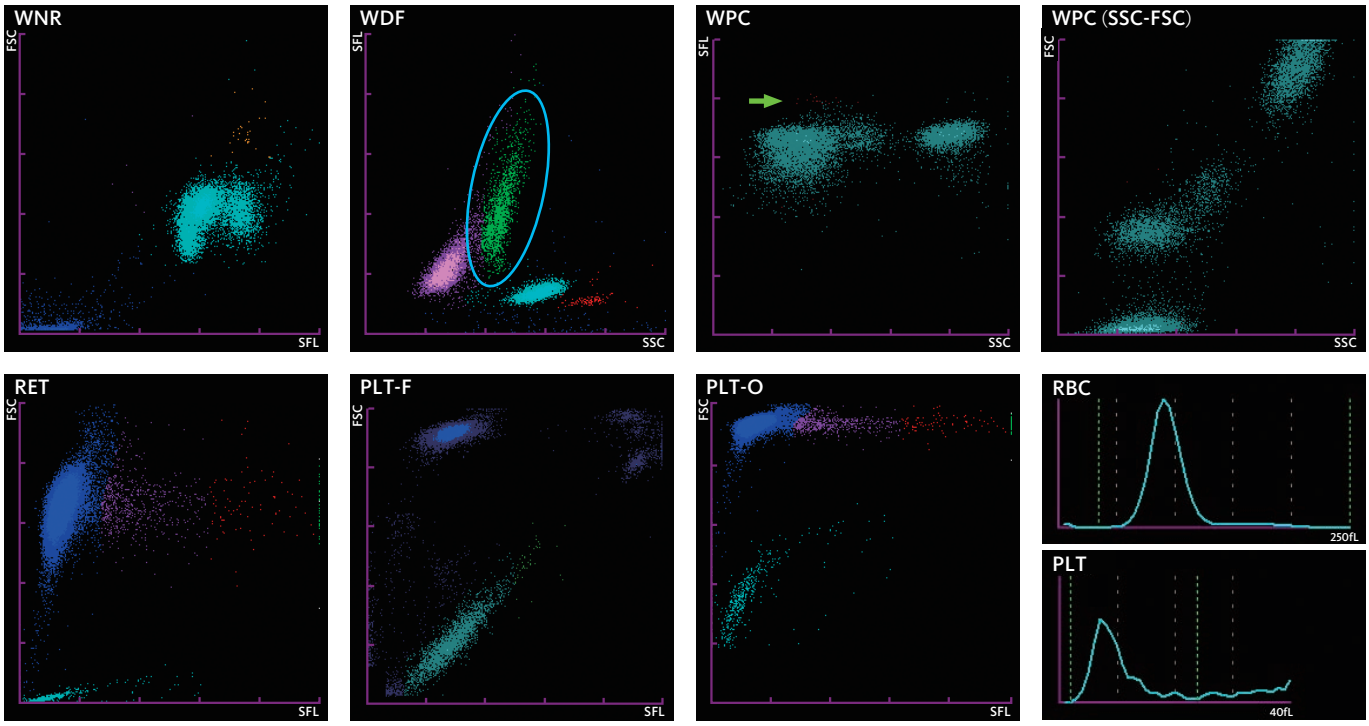
WBC	11.58	10^9/L		NEUT	3.85	10^9/L	* 33.3 % *
RBC	3.74	10^{12}/L		LYMPH	6.05	10^9/L	* 52.2 % *
HGB	109	g/L		MONO	1.53	10^9/L	* 13.2 % *
HCT	0.341	L/L		EO	0.12	10^9/L	1.0 %
MCV	91.2	fL		BASO	0.03	10^9/L	0.3 %
MCH	29.1	pg		IG	0.03	10^9/L	0.3 %
MCHC	320	g/L		RET	35.9	10^9/L	0.96 %
PLT	29	10^9/L		IRF	11.8	%	
RDW-SD	43.2	fL		LFR	88.2	%	
RDW-CV	13.0	%		MFR	10.1	%	
PDW	10.2	fL		HFR	1.7	%	
MPV	9.8	fL		RET-He	29.3	pg	
P-LCR	22.5	%		IPF	0.5	10^9/L	1.5 %
PCT	0.0003	L/L	–				
NRBC	0.0	10^9/L	0.0/100 WBC				

Flags

WBC Flag(s)
Lymphocytosis
Monocytosis
Abn Lympho?

RBC Flag(s)

PLT Flag(s)
Thrombocytopenia



Note

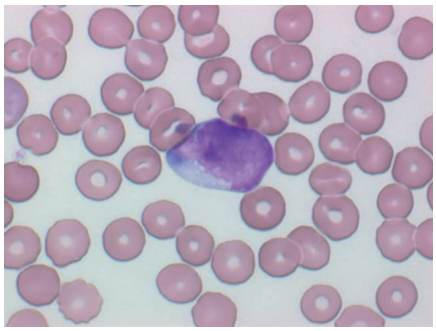
The ratio of monocytes is higher than in the visual count, and the blasts seen in the smears seem to be plotted in the MONO cluster of the WDF scattergram (○). These cells are detected as abnormal cells in the WPC scattergram (↑, indicated in red), which agrees with the visual findings.

Case history

The patient came for a medical examination because of diarrhea and bloody stools. Blood tests revealed anemia and thrombocytopenia.

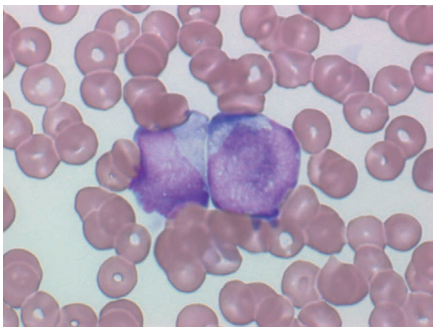
Blood smear (May-Giemsa staining)

PB



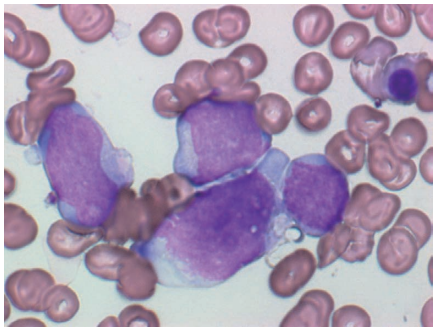
×600

PB



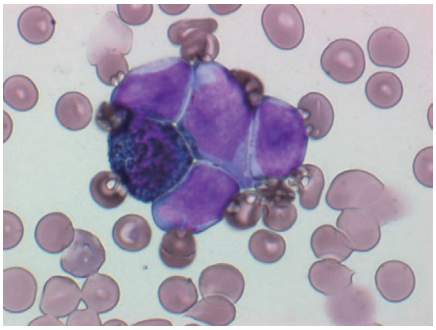
×600

BM



×600

BM (Myeloperoxidase staining)



×600

Note

Peripheral blood shows leukocytosis and thrombocytopenia. There are 4% blasts. The blasts are medium to large in size with a low N/C ratio. Nuclear chromatin is fine and reticulated, and several nucleoli are seen.

Bone marrow shows normoplasia with an increase in blasts (34.8%). The blasts are variable in size with occasional large blasts noted. Nuclei are round to irregular with fine reticulated nuclear chromatin and distinct nucleoli. Some of the blasts exhibit cytoplasmic blebbing. The blasts are MPO negative.

Visual differential counts

PB	
Myeloblast	4.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	1.0
Segmented N.	32.5
Lymphocytes	57.0
Monocytes	4.0
Basophils	0.0
Eosinophils	1.5
Atypical Lymph	0.0
NRBC	0.0/100 WBC

Other tests

LD (U/L) 428(110-219)

BM	
NCC (×10⁴/μL)	6.6
Megakaryo (/μL)	<15
Myeloblast	34.8
Promyelo	0.8
Myelo	5.4
Meta	2.9
Stab	4.2
Segmented N.	7.5
Eosinophils	0.9
Basophils	0.0
Lymphocytes	29.5
Monocytes	3.0
Plasma	0.4
Macrophage	0.5
Megakaryo	0.0

Pro Erythroblast	0.0
Baso Erythroblast	0.0
Poly Erythroblast	10.1
Orth Erythroblast	0.0
M:E ratio	5.6
MPO staining	<3 among blasts

Chromosome analysis

G-band 46,XY [20]

unit : %

Cell surface antigen expressions (BM)

T-Cell	
CD2	1.8
CD4	0.1
CD5	0.9
CD7	1.0
CD8	0.3

B-Cell	
CD19	2.0

NK-Cell	
CD56	2.1

Myeloid	
CD11b	6.0
CD13	53.0
CD14	9.3
CD33	42.4
CD36	36.4
CD64	1.2
CD117	2.1
MPO	2.1

Other	
CD34	11.0
CD38	97.5
CD41b	87.2
CD61	89.2
Gly-A	2.8
HLA-DR	12.4

CD45 gating

unit : %

Note

The bone marrow cells by CD45 blast gating are positive for the granulocyte markers CD13, CD33, and CD36. There is a strong expression of the megakaryocyte markers CD41b and CD61. Cytoplasmic MPO (myeloperoxidase) staining is negative.

AML with myelodysplasia-related changes

Information from XN-Series

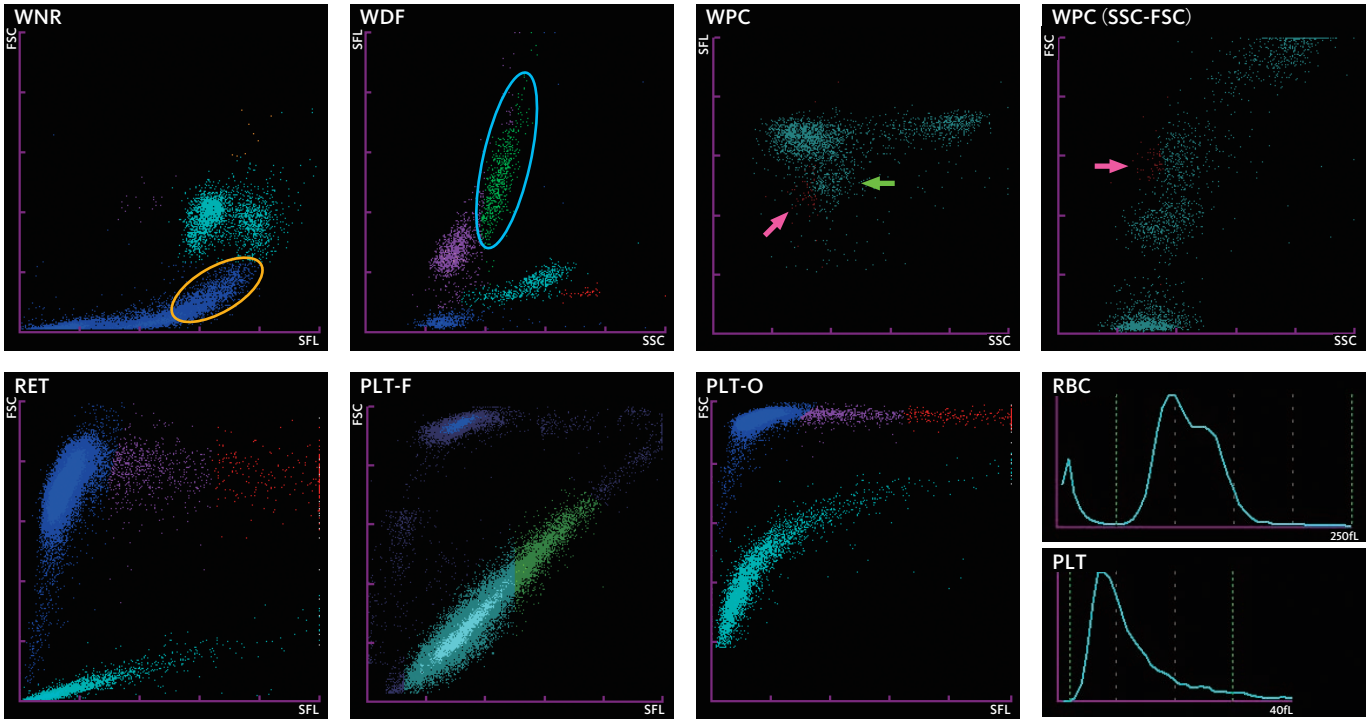
WBC	2.83	10^9/L	–	NEUT	0.82	10^9/L	*	28.9 % *
RBC	2.3	10^{12}/L	–	LYMPH	1.44	10^9/L	*	50.9 % *
HGB	83	g/L		MONO	0.52	10^9/L	*	18.4 % *
HCT	0.252	L/L	–	EO	0.04	10^9/L		1.4 %
MCV	109.6	fL		BASO	0.01	10^9/L		0.4 %
MCH	36.1	pg		IG	0.01	10^9/L		0.4 %
MCHC	329	g/L		RET	41.9	10^9/L		1.82 %
PLT	248	10^9/L		IRF	25.7	%		
RDW-SD	76.8	fL	+	LFR	74.3	%		
RDW-CV	20.0	%	+	MFR	13.5	%		
PDW	14.7	fL		HFR	12.2	%		
MPV	11.8	fL		RET-He	38.2	pg		
P-LCR	37.2	%		IPF	31.6	10^9/L		12.2 %
PCT	0.0029	L/L						
NRBC	0.02	10^9/L	0.7/100 WBC					

Flags

WBC Flag(s)
Neutropenia
Blasts?

RBC Flag(s)
Anisocytosis
Anemia

PLT Flag(s)



Note

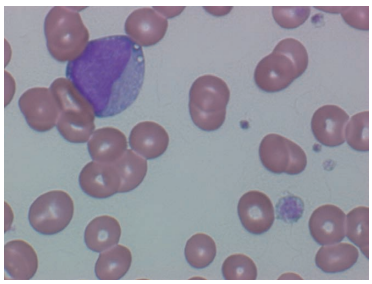
The white blood cell count is slightly decreased and the monocyte ratio is higher than in the visual count. This is apparently because most of the blasts seen in the smears are plotted in the MONO cluster of the WDF scattergram (○). There is a cluster (⬆) that is assumed to consist of blasts on the WPC scattergram, and some cells are detected as abnormal cells in the WPC and WPC (SSC-FSC) scattergrams (⬆, indicated in red), with the "Blasts?" flag also displayed. Many small megakaryocytes are seen in the smears and they seem to have been plotted in the immature platelet fraction (IPF) area (indicated in green) of the PLT-F scattergram and the area extending from the Debris cloud on the WNR scattergram (○).

Case history

The peripheral blood of a patient being followed up for myelodysplastic syndrome shows an increase in blasts.

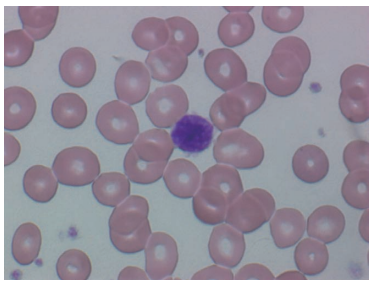
Blood smear (May-Giemsa staining)

PB



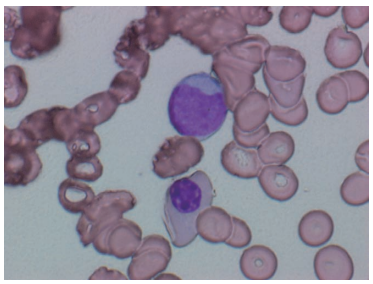
×600

PB



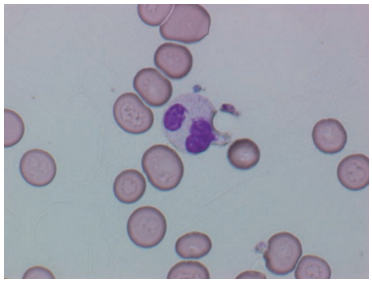
×600

BM



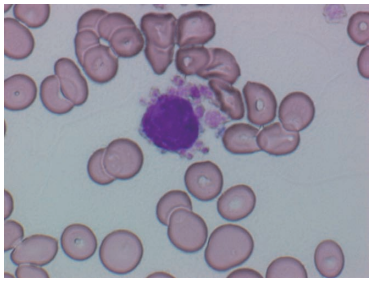
×600

BM



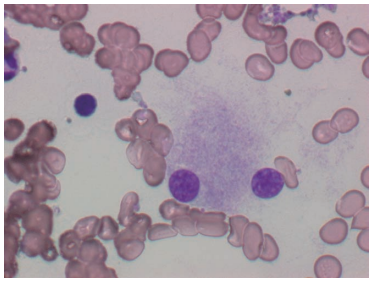
×600

BM



×600

BM



×400

Note

The peripheral blood reveals anemia and a decrease in white blood cells with 15% blasts. There are also small megakaryocytes (6/100 WBC).
Bone marrow shows hypoplasia with 20% blasts. Blasts are medium sized with a low N/C ratio. Nuclei are round in shape with fine nuclear chromatin and several nucleoli. All three blood cell lines show signs of morphological dysplasia. Pseudo-Pelger anomaly and hypogranulation are seen in neutrophils. Also seen are megaloblastoid changes in erythroblasts, micromegakaryocytes and megakaryocytes with unilobular nuclei (dysplasia is noted in greater than 50% of cells in each blood cell lineage).
Based on the above, AML with myelodysplasia-related changes is diagnosed.

Visual differential counts

PB

Myeloblast	15.0
Promyelo	0.0
Myelo	1.0
Meta	0.0
Stab	0.0
Segmented N.	31.0
Lymphocytes	45.0
Monocytes	8.0
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
NRBC	1.0/100 WBC
Megakaryo	6.0/100 WBC

Other tests

LD (U/L) 314(110-219)

BM

NCC ($\times 10^4$/μL)	0.6
Megakaryo (/μL)	<15
Myeloblast	20.0
Promyelo	0.6
Myelo	0.9
Meta	0.9
Stab	0.0
Segmented N.	13.6
Eosinophils	4.6
Basophils	0.4
Lymphocytes	33.2
Monocytes	8.6
Plasma	1.0
Macrophage	0.8
Megakaryo	0.6
Pro Erythroblast	0.0
Baso Erythroblast	1.2
Poly Erythroblast	13.6
Orth Erythroblast	0.0
M:E ratio	2.8

Chromosome analysis

G-band 46,XY [6]

unit : %

Cell surface antigen expressions (BM)

T-Cell	
CD2	0.9
CD5	0.3
CD7	1.2
B-Cell	
CD19	1.3
NK-Cell	
CD56	1.8
Myeloid	
CD11b	16.5
CD13	91.5
CD14	5.0
CD33	97.4
CD36	7.3
CD64	13.2
CD117	70.6
MPO	71.4
Other	
CD34	2.3
CD38	97.3
CD41b	12.8
CD61	15.3
Gly-A	10.2
HLA-DR	59.8

CD45 gating

unit : %

Note

Bone marrow cells are positive for the myeloid markers CD13, CD33, CD117 and MPO (myeloperoxidase).

Myelodysplastic syndrome - refractory anemia with excess blasts (RAEB-1)

Information from XN-Series

WBC	4.81	10^9/L	
RBC	2	10^{12}/L	–
HGB	70	g/L	–
HCT	0.228	L/L	–
MCV	114.0	fL	+
MCH	35.0	pg	
MCHC	307	g/L	–
PLT	26	10^9/L	*
RDW-SD	63.0	fL	+
RDW-CV	16.5	%	+
PDW	----	fL	
MPV	----	fL	
P-LCR	----	%	
PCT	----	L/L	
NRBC	1.43	10^9/L	29.7/100 WBC

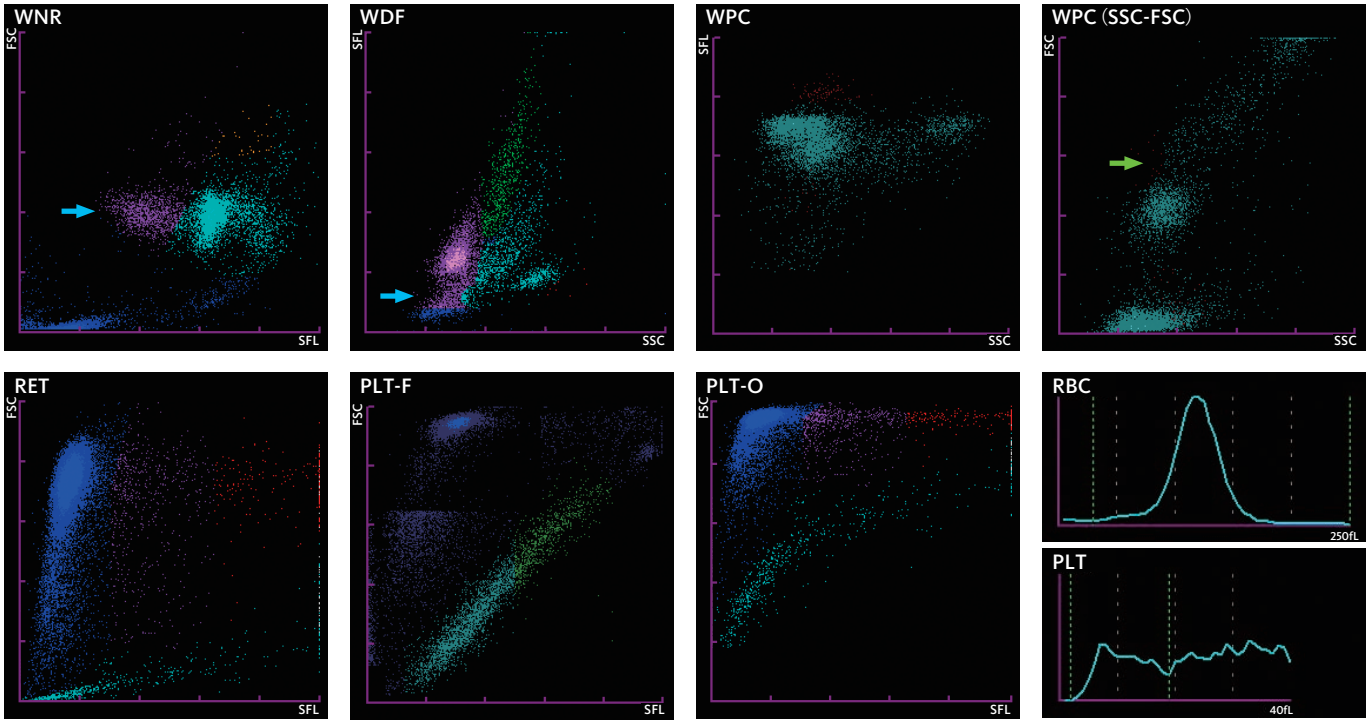
NEUT	1.71	10^9/L	*	35.6 %	*
LYMPH	2.55	10^9/L	*	53.0 %	*
MONO	0.50	10^9/L	*	10.4 %	*
EO	0.01	10^9/L		0.2 %	
BASO	0.04	10^9/L		0.8 %	
IG	0.02	10^9/L		0.4 %	
RET	37.8	10^9/L		1.89 %	
IRF	25.6	%			
LFR	74.4	%			
MFR	13.1	%			
HFR	12.5	%			
RET-He	28.7	pg			
IPF	8.0	10^9/L		24.3 %	

Flags

WBC Flag(s)
NRBC Present
Blasts?

RBC Flag(s)
Macrocytosis
Anemia
Fragments?

PLT Flag(s)
PLT Abn Distribution
Thrombocytopenia



Note

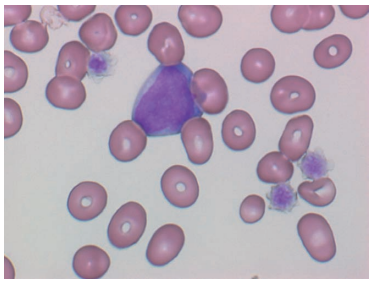
NRBC are present. An NRBC cluster is seen on the WNR scattergram, and plots are seen in the NRBC detection area of the WDF scattergram (⬆). Plots are also seen in the abnormal cell detection area of the WPC and WPC (SSC-FSC) scattergrams (⬆). The "Blasts?" flag is also displayed, which matches the finding of blasts in the smear. The red blood cell count and hemoglobin level are low and MCV and MCH are high, and normochromic macrocytic anemia is thus suspected. The platelet count is low and IPF% (immature platelet fraction) is elevated at 24.3%. Plots are seen in the IPF area (indicated in green) of the PLT-F scattergram. It is assumed that the giant platelets seen in the smears are plotted in this area. The PLT histogram shows an abnormal pattern due to the effect of these cells, and the "PLT Abn Distribution" flag is displayed. The platelet count measured by electrical resistance method cannot detect these cells. (PLT-I: 26 x $10^3/\mu$L).

Case history

The patient was diagnosed with anemia and thrombocytopenia during a routine health checkup and was referred to our hospital.

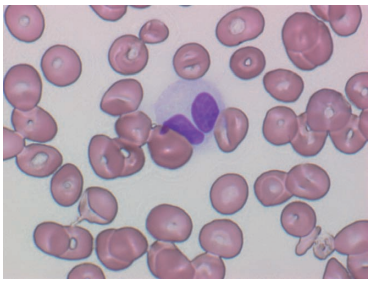
Blood smear (May-Giemsa staining)

PB



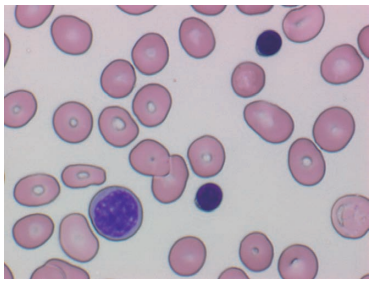
×600

PB



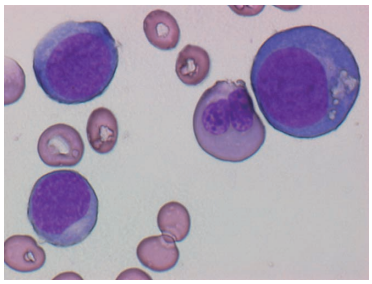
×600

PB



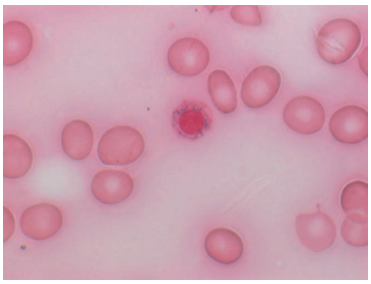
×600

BM



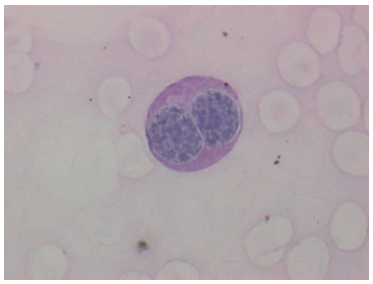
×600

BM (PAS staining)



×600

BM (Fe staining)



×600

Note

Peripheral blood shows anemia and thrombocytopenia. There are 4% blasts. Blasts are of medium size with a high N/C ratio. Nuclear chromatin is fine with several large and distinct nucleoli. Pseudo-Pelger anomaly and hypogranulation are observed in neutrophils. Many erythroblasts are present (40/100 WBC). Giant platelets and micromegakaryocytes are also seen.
Bone marrow shows slight hypoplasia with increased erythroblasts. The erythroid lineage cells cells show strong dysplasia with megaloblastic changes in many of the erythroblasts. Multinucleated erythroblasts with 2 to 4 nuclei are also seen.
34% ring sideroblasts are seen on Fe staining, and PAS -positive erythroblasts are present.
Chromosome analysis reveals abnormalities, including -5 and -7, in 16/20 cells.
Based on the above, the patient is diagnosed with myelodysplastic syndrome (MDS RAEB-1).

Visual differential counts

PB

Myeloblast	4.0
Promyelo	0.0
Myelo	6.0
Meta	0.0
Stab	1.0
Segmented N.	22.0
Lymphocytes	64.0
Monocytes	3.0
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
NRBC	40.0/100 WBC
Megakaryo	1.0/100 WBC

Other tests
LD (U/L) 620(110-219)

BM

NCC (×10⁴/μL)	7.8
Megakaryo (/μL)	60
Myeloblast	2.5
Promyelo	0.7
Myelo	2.8
Meta	1.2
Stab	1.4
Segmented N.	2.3
Eosinophils	2.4
Basophils	0.0
Lymphocytes	15.5
Monocytes	0.6
Plasma	0.0
Macrophage	0.1
Megakaryo	0.0

Pro Erythroblast	1.6
Baso Erythroblast	5.3
Poly Erythroblast	51.3
Orth Erythroblast	12.3
M:E ratio	0.2

Fe staining
96% positive
Ring sideroblasts 34%
PAS staining
Erythroblast positive

Chromosome analysis
G-band
46,XY,-5,add(6)(p25),-7,+20,+mar [16] / 46,XY [4]

unit : %

Myelodysplastic syndrome - refractory anemia with excess blasts (RAEB-2)

Information from XN-Series

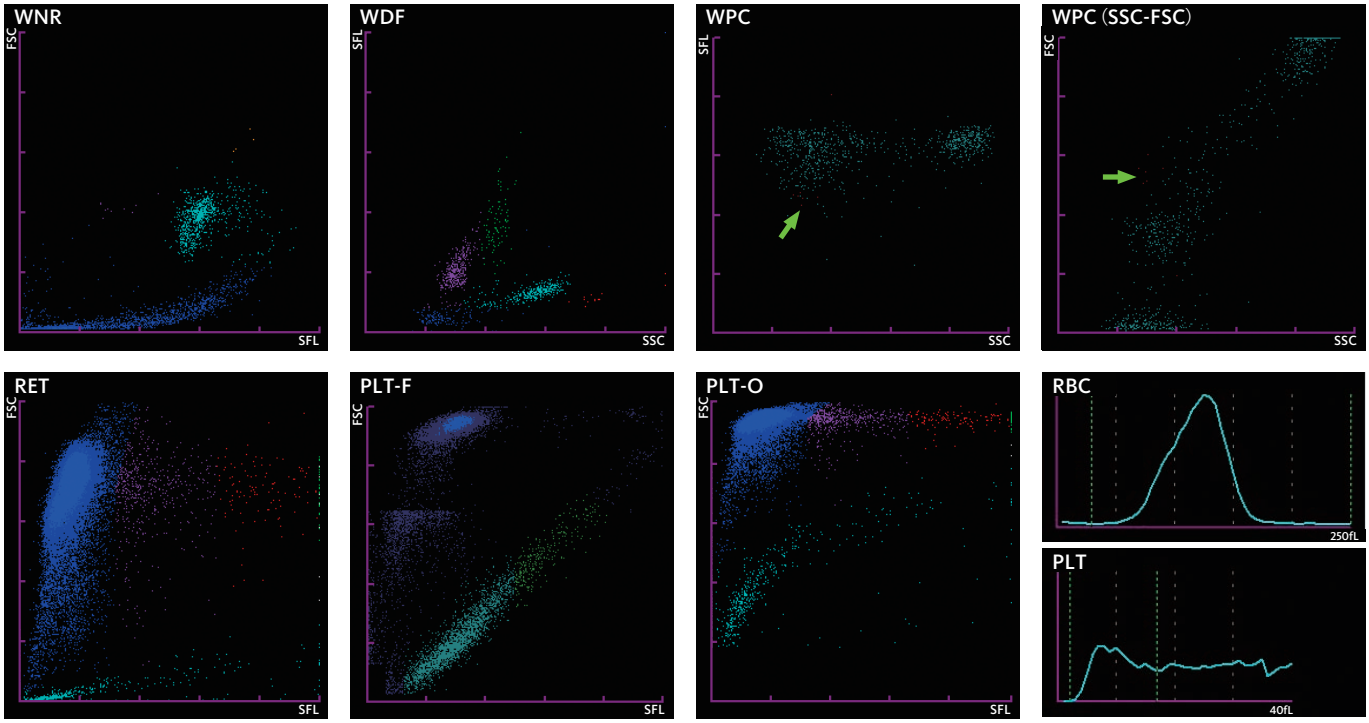
WBC	0.91	10^9/L	–	NEUT	0.41	10^9/L	*	45.0 % *
RBC	3.3	10^{12}/L		LYMPH	0.41	10^9/L	*	45.1 % *
HGB	120	g/L		MONO	0.08	10^9/L	*	8.8 % *
HCT	0.376	L/L		EO	0.01	10^9/L	*	1.1 % *
MCV	113.9	fL	+	BASO	0.00	10^9/L	*	0.0 % *
MCH	36.4	pg		IG	0.01	10^9/L	*	1.1 % *
MCHC	319	g/L		RET	33.0	10^9/L		1.00 %
PLT	26	10^9/L	*	IRF	17.5	%		
RDW-SD	77.2	fL	+	LFR	82.5	%		
RDW-CV	18.5	%	+	MFR	13.7	%		
PDW	----	fL		HFR	3.8	%		
MPV	----	fL		RET-He	31.8	pg		
P-LCR	----	%		IPF	3.0	10^9/L		10.4 %
PCT	----	L/L						
NRBC	0.02	10^9/L	*	2.2/100 WBC *				

Flags

WBC Flag(s)
- Neutropenia
- Lymphopenia
- Leukocytopenia
- NRBC Present
- Blasts?

RBC Flag(s)
- Anisocytosis
- Macrocytosis
- Fragments?

PLT Flag(s)
- PLT Abn Distribution
- Thrombocytopenia



Note

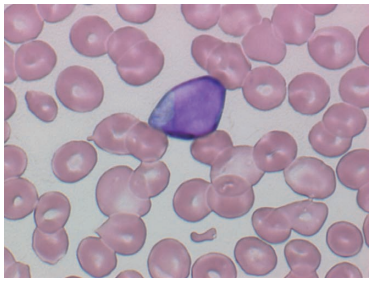
The white blood cell count is low, and there are a small number of plots in the related WNR, WDF and WPC scattergrams. However, the "Blasts?" flag is displayed because of the small number of plots detected as abnormal cells in the WPC scattergram (⬆, indicated in red). MCV and MCH show high values and the patient is suspected to have normochromic macrocytic anemia. RDW-SD is also high, and the RBC histogram indicates anisocytosis, and the "Anisocytosis" flag is thus displayed. IPF% (immature platelet fraction) is lower than in the case described on the previous page, and the plots in the IPF area (indicated in green) of the PLT-F scattergram are few in number. On the other hand, the PLT histogram seems to be affected by the giant platelets seen in the smears, and "PLT Abn Distribution" flag is displayed (the platelet count measured by the impedance method is PLT-I: 26 x $10^3/\mu$L).

Case history

The patient experienced shortness of breath on exertion. Testing of peripheral blood revealed pancytopenia.

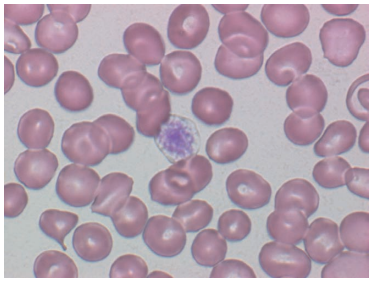
Blood smear (May-Giemsa staining)

PB



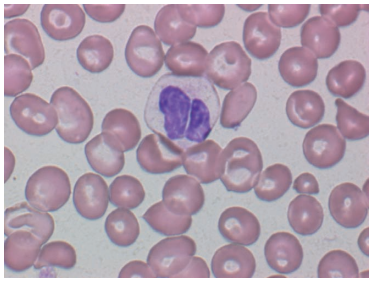
×600

PB



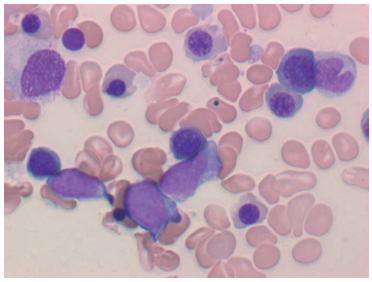
×600

PB



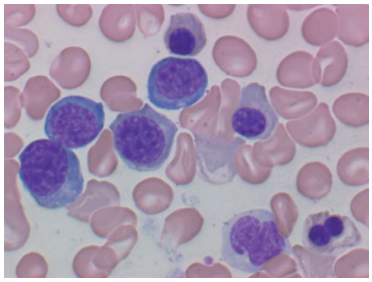
×600

BM



×400

BM



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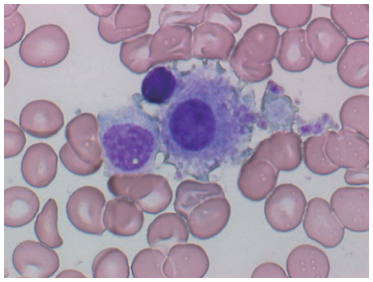
BM



×600

Note

A decrease in the white blood cell and platelet counts is observed in peripheral blood with 1% blasts. Pseudo-Pelger anomaly and hypogranulation are seen in neutrophils. Giant platelets are also present.
The bone marrow is largely normoplastic with an increase in erythroblasts. There are signs of dysplasia in the erythroid series, such as megaloblastic changes and some multinucleated erythroblasts with 2 to 3 nuclei. Blasts are increased at 11%, and they are large in size with a low N/C ratio. Nuclei are irregular in shape with fine chromatin and large nucleoli. As in peripheral blood, Pseudo-Pelger anomaly and hypogranulation are seen in neutrophils. Severe dysplasia, including small megakaryocytes, mononuclear megakaryocytes and megakaryocytes with multiple widely separated nuclei, is seen in megakaryocytes.
Based on the above, the patient is diagnosed as having myelodysplastic syndrome (MDS RAEB-2).

Visual differential counts

PB

Myeloblast	1.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	2.0
Segmented N.	42.0
Lymphocytes	46.0
Monocytes	6.0
Basophils	1.0
Eosinophils	2.0
Atypical Lymph	0.0
NRBC	1.0/100 WBC

Other tests

LD (U/L)
155(110-219)

BM

NCC (×10⁴/μL)	7.5
Megakaryo (/μL)	30
Myeloblast	11.0
Promyelo	0.8
Myelo	6.7
Meta	3.5
Stab	4.3
Segmented N.	9.8
Eosinophils	1.4
Basophils	3.3
Lymphocytes	5.3
Monocytes	2.4
Plasma	0.3
Macrophage	1.0
Megakaryo	0.4

Pro Erythroblast	0.1
Baso Erythroblast	1.4
Poly Erythroblast	45.0
Orth Erythroblast	3.3
M:E ratio	0.8

Chromosome analysis

G-band 46,XY[20]

unit : %

Chronic myelomonocytic leukemia (CMML)

Information from XN-Series

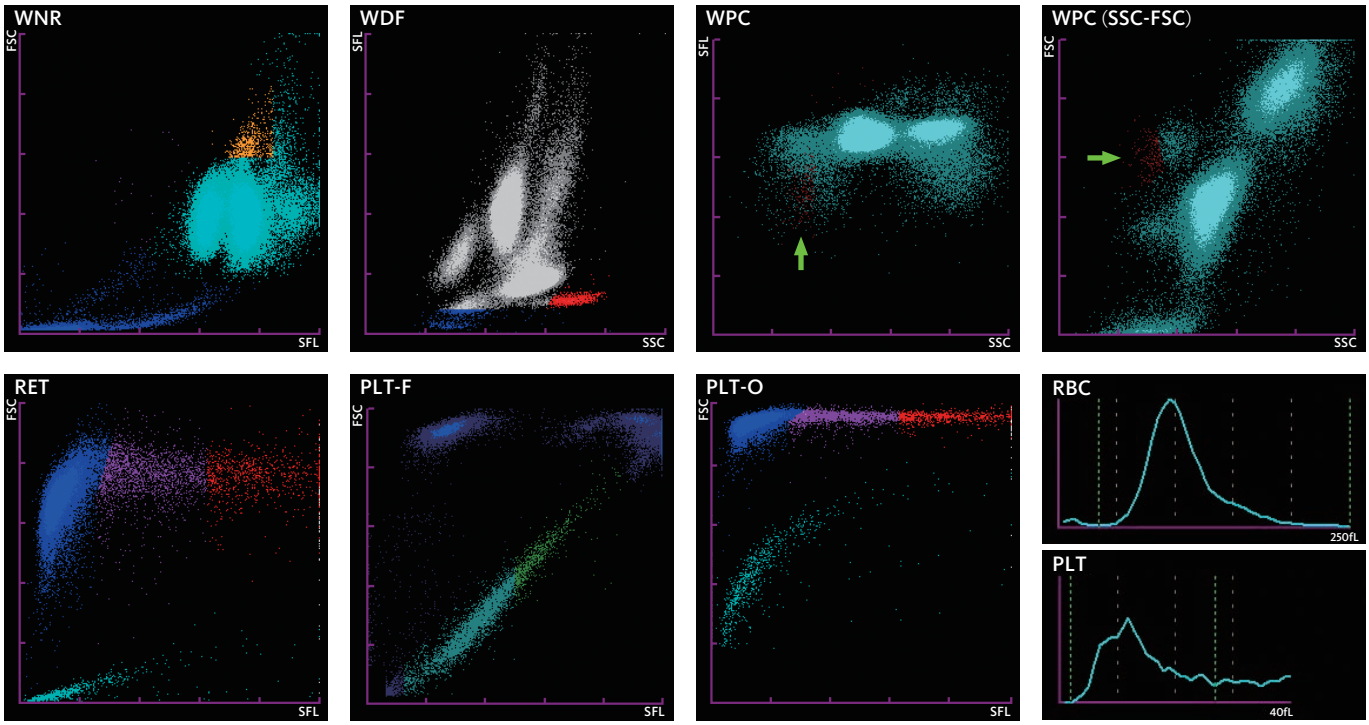
WBC	91.21	10^9/L	+	NEUT	46.73	10^9/L	*	51.2 % *
RBC	2.57	10^{12}/L		LYMPH	3.19	10^9/L	*	3.5 % *
HGB	83	g/L		MONO	40.02	10^9/L	*	43.9 % *
HCT	0.266	L/L		EO	0.54	10^9/L	*	0.6 % *
MCV	103.5	fL		BASO	0.73	10^9/L	+	0.8 %
MCH	32.3	pg		IG	6.5	10^9/L	*	7.1 % *
MCHC	312	g/L		RET	132.1	10^9/L		5.14 %
PLT	44	10^9/L	*	IRF	29.9	%		
RDW-SD	75.7	fL	+	LFR	70.1	%		
RDW-CV	22.5	%	+	MFR	21.1	%		
PDW	----	fL		HFR	8.8	%		
MPV	----	fL		RET-He	36.8	pg		
P-LCR	----	%		IPF	7.0	10^9/L		15.5 %
PCT	----	L/L						
NRBC	0.03	10^9/L	0.0/100 WBC					

Flags

WBC Flag(s)
- WBC Abn Scattergram
- Neutrophilia
- Monocytosis
- Basophilia
- Leukocytosis
- IG Present
- Blasts?
- Left Shift?

RBC Flag(s)
- Anisocytosis
- Anemia
- Reticulocytosis

PLT Flag(s)
- PLT Abn Distribution
- Thrombocytopenia



Note

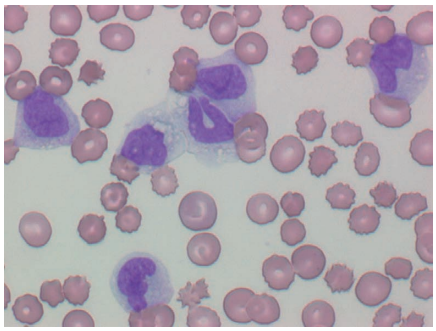
The white blood cell count is considerably elevated and separation of clusters is impossible on the WDF scattergram. Although no blasts are seen in the smears, there are some plots detected as abnormal cells in the WPC scattergram (⬆, indicated in red) , and the “Blasts?” flag is displayed. The red blood cell count is low and RDW-SD has a high value. The RBC histogram also suggests anisocytosis, and the “Anisocytosis” flag is displayed.

Case history

A case of possible CMML being monitored.

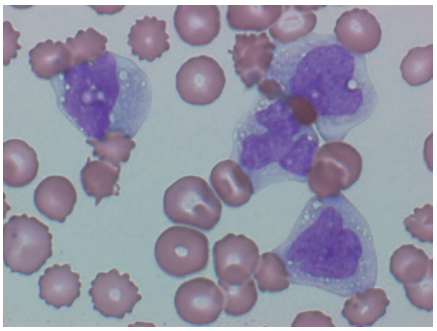
Blood smear (May-Giemsa staining)

PB



×400

PB



×600

Note

The peripheral blood shows leukocytosis, anemia and thrombocytopenia. Mature monocytes are increased (59%). Immature granulocytes are evident but no blasts are seen.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	1.0
Meta	1.0
Stab	2.5
Segmented N.	33.5
Lymphocytes	2.5
Monocytes	59.0
Basophils	0.5
Eosinophils	0.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

Other tests

LD (U/L)
221(110-219)

unit : %

Chronic myelogenous leukemia (CML)

Information from XN-Series

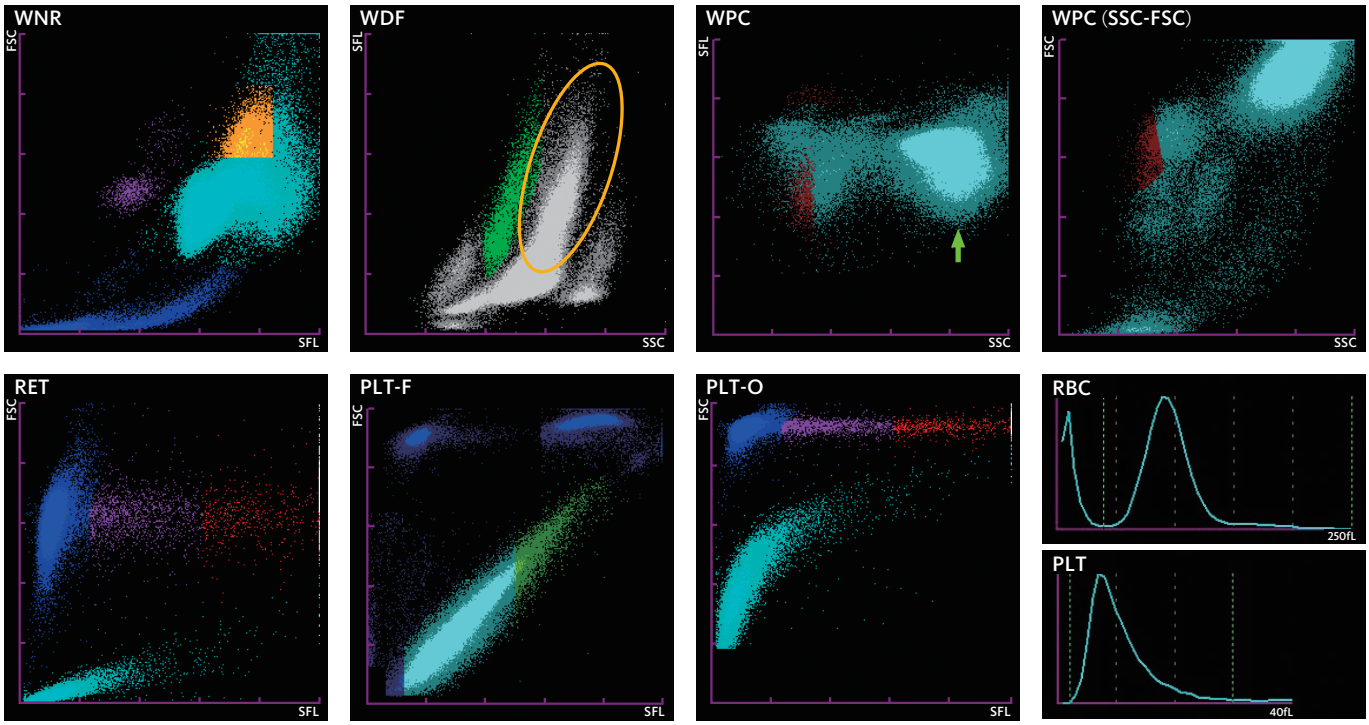
WBC	218.53	10^9/L	*	NEUT	186.59	10^9/L	*	85.4 % *
RBC	3.72	10^{12}/L		LYMPH	5.96	10^9/L	*	2.7 % *
HGB	103	g/L		MONO	6.52	10^9/L	*	3.0 % *
HCT	0.343	L/L		EO	5.66	10^9/L	*	2.6 % *
MCV	92.2	fL		BASO	13.80	10^9/L	*	6.3 % *
MCH	27.7	pg		IG	72.48	10^9/L	*	33.2 % *
MCHC	300	g/L	–	RET	100.1	10^9/L		2.69 %
PLT	1031	10^9/L	*	IRF	30.8	%		
RDW-SD	56.9	fL	+	LFR	69.2	%		
RDW-CV	17.0	%	+	MFR	18.4	%		
PDW	12.5	fL	*	HFR	12.4	%		
MPV	10.6	fL	*	RET-He	26.3	pg		
P-LCR	30.0	%	*	IPF	50.3	10^9/L	*	4.7 % *
PCT	0.011	L/L	*					
NRBC	1.52	10^9/L	*	0.7/100 WBC *				

Flags

WBC Flag(s)
- WBC Abn Scattergram
- Neutrophilia
- Lymphocytosis
- Monocytosis
- Eosinophilia
- Basophilia
- Leukocytosis
- IG Present
- Blasts?
- Left Shift?

RBC Flag(s)

PLT Flag(s)
- Thrombocytosis
- PLT Clumps?



Note

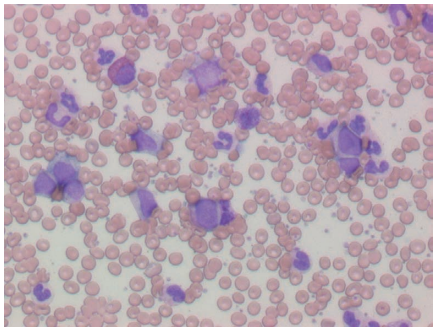
The white blood cell count is markedly elevated and separation of clusters is impossible in parts of the WDF scattergram. However, there are many plots (○) in the IG (immature granulocyte) area, which match the visual findings. The WPC scattergram shows characteristics of the presence of immature granulocytes, the cluster corresponding to granulocytes spreading downwards (↑). In addition, the blasts seen in the smears are detected as abnormal cells in the WPC and WPC (SSC-FSC) scattergrams (indicated in red), and the “Blasts?” flag is also displayed.

Case history

A considerable increase in white blood cells was detected during a health checkup.

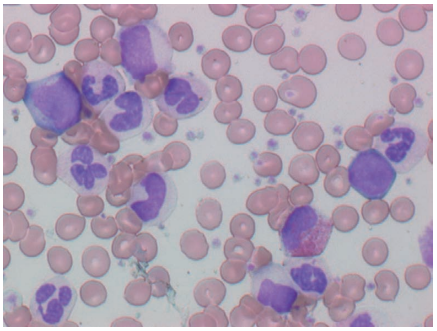
Blood smear (May-Giemsa staining)

PB



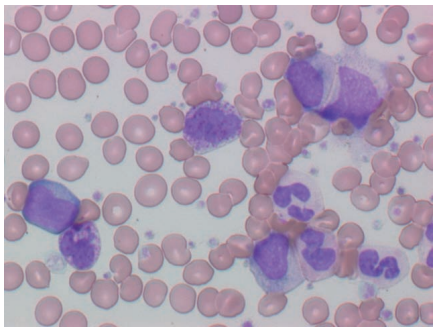
×200

PB



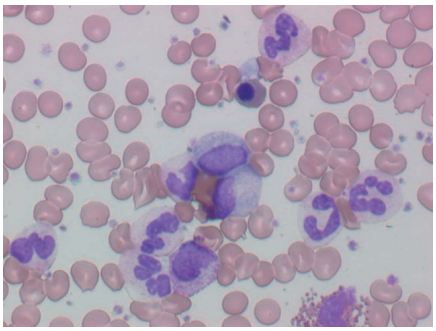
×400

PB



×400

PB



×400

Note

Peripheral blood shows leukocytosis, anemia and a high platelet count. White blood cells at various stages of maturity from blasts to mature neutrophils are seen. An increase in eosinophils and basophils is also visible. The NAP score is low and peripheral blood is positive for the *BCR-ABL* fusion gene. Based on the above, the patient is diagnosed with CML.

Visual differential counts

PB

Myeloblast	0.5
Promyelo	0.5
Myelo	27.5
Meta	10.5
Stab	13.0
Segmented N.	33.5
Lymphocytes	1.0
Monocytes	1.5
Basophils	6.0
Eosinophils	6.0
Atypical Lymph	0.0
NRBC	3.0/100 WBC

Other tests

LD (U/L)
762(110-219)

unit : %

Other tests

NAP score	42
Type 0	78
Type 1	8
Type 2	9
Type 3	4
Type 4	1
Type 5	0

Chromosomal test
46,XX,t(9;22)(q34;q11.2) [20]

BCR-ABL fusion gene test (RT-PCR)
Major *BCR2-ABL*-positive

Polycythemia vera (PV)

Information from XN-Series

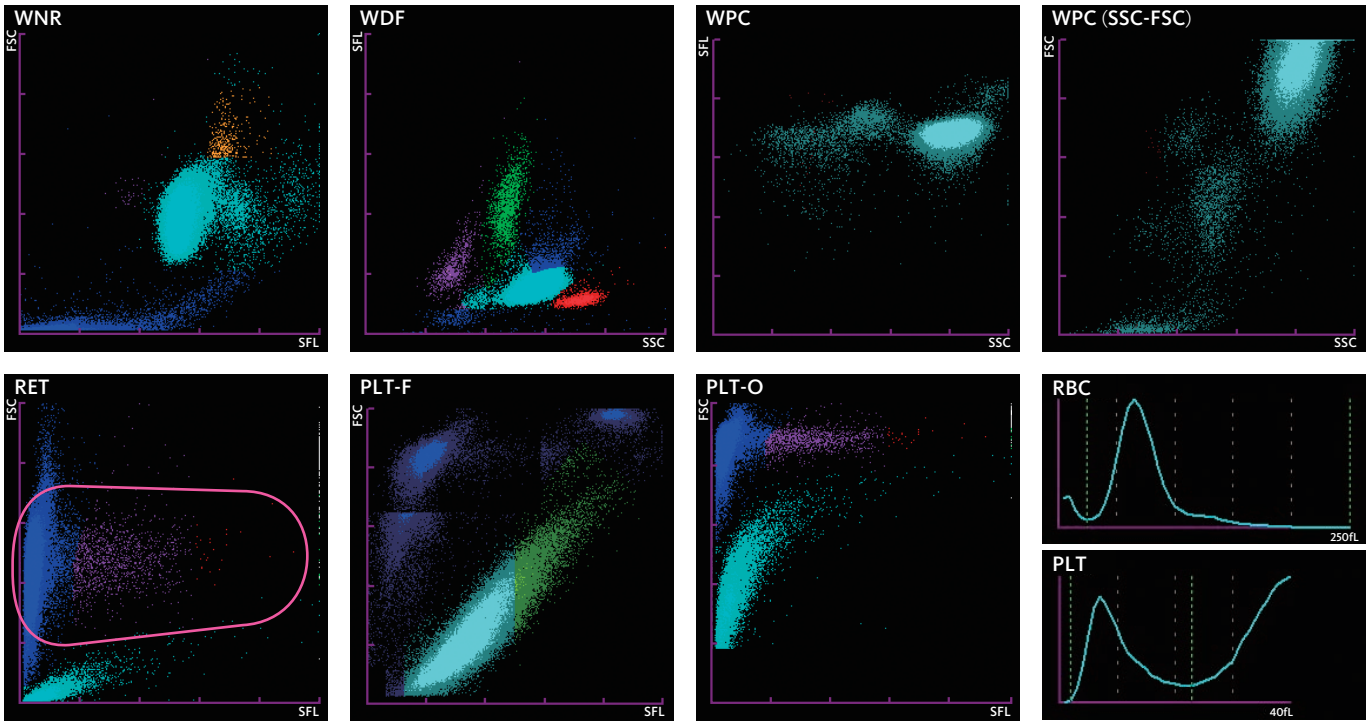
WBC	53.56	10^9/L	+	NEUT	49.10	10^9/L	*	91.8 % *
RBC	8.49	10^{12}/L	+	LYMPH	0.88	10^9/L	*	1.6 % *
HGB	149	g/L		MONO	1.40	10^9/L	*	2.6 % *
HCT	0.585	L/L	+	EO	1.79	10^9/L	+	3.3 %
MCV	68.9	fL	–	BASO	0.39	10^9/L	+	0.7 %
MCH	17.6	pg	–					
MCHC	255	g/L	–	IG	1.61	10^9/L		3.0 %
PLT	961	10^9/L		RET	----	10^9/L		---- %
				IRF	----	%		
RDW-SD	49.7	fL		LFR	----	%		
RDW-CV	23.7	%	+	MFR	----	%		
PDW	14.7	fL	*	HFR	----	%		
MPV	10.4	fL	*	RET-He	----	pg		
P-LCR	30.7	%	*					
PCT	0.01	L/L	*	IPF	85.5	10^9/L	*	9.3 % *
NRBC	0.04	10^9/L	0.1/100 WBC					

Flags

WBC Flag(s)
- Neutrophilia
- Monocytosis
- Eosinophilia
- Basophilia
- Leukocytosis
- IG Present
- Blasts?

RBC Flag(s)
- Anisocytosis
- Microcytosis
- Hypochromia
- Erythrocytosis
- Iron Deficiency?
- Fragments?

PLT Flag(s)
- PLT Abn Distribution
- Thrombocytosis
- PLT Clumps?



Note

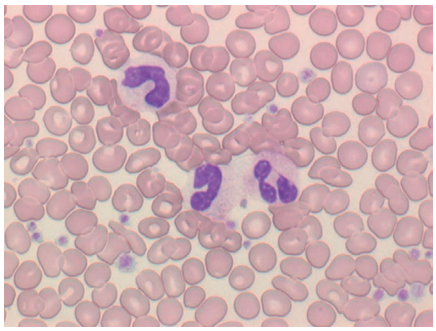
White blood cell, red blood cell and platelet counts are high. Neutrophils constitute the main part of the white blood cell fraction. Low values of MCH and MCHC suggest that the red blood cells are hypochromic, and the “Hypochromia” flag is displayed. The mature red blood cell and RET clusters on the RET scattergram are generally extended down towards the weaker forward-scattered light region (○), indicating an increase in microcytic red blood cells. MCV is also low at 68.9 fL.

Case history

The patient was found to display polycythemia during a health checkup.

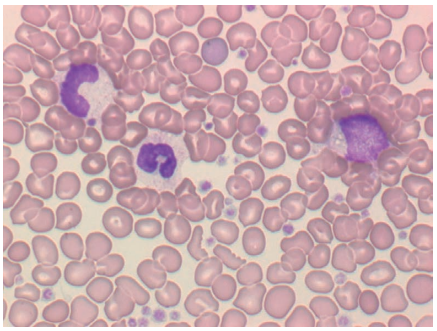
Blood smear (May-Giemsa staining)

PB



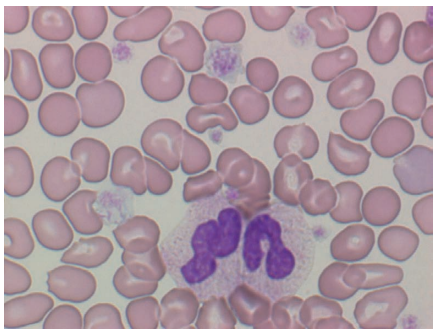
×400

PB



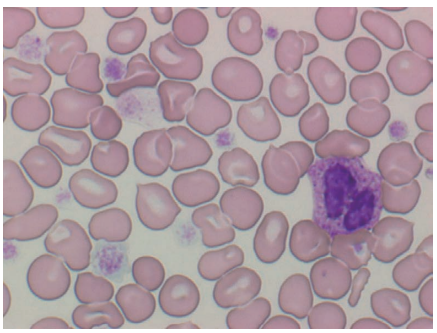
×400

PB



×600

PB



×600

Note

Peripheral blood shows high counts of blood cells of all 3 lineages. The red blood cell density is high in the smears, which show small red blood cells. Stab neutrophils have increased among white blood cells and immature granulocytes have also appeared although in small numbers. Platelets are variable in size, and there are platelets as large as red blood cells, and also giant platelets. Blood erythropoietin has decreased considerably, which leads to the diagnosis of polycythemia vera.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	1.0
Meta	0.5
Stab	16.0
Segmented N.	74.0
Lymphocytes	2.0
Monocytes	3.5
Basophils	0.5
Eosinophils	2.5
Atypical Lymph	0.0
NRBC	0.0/100 WBC

Other tests

LD (U/L)
357(110-219)

Fe (μg/dL)
14(60-180)

TIBC (μg/dL)
409(220-380)

UIBC (μg/dL)
395(120-300)

Erythropoietin (mIU/mL)
3(8-36)

unit : %

Essential thrombocythemia (ET)

Information from XN-Series

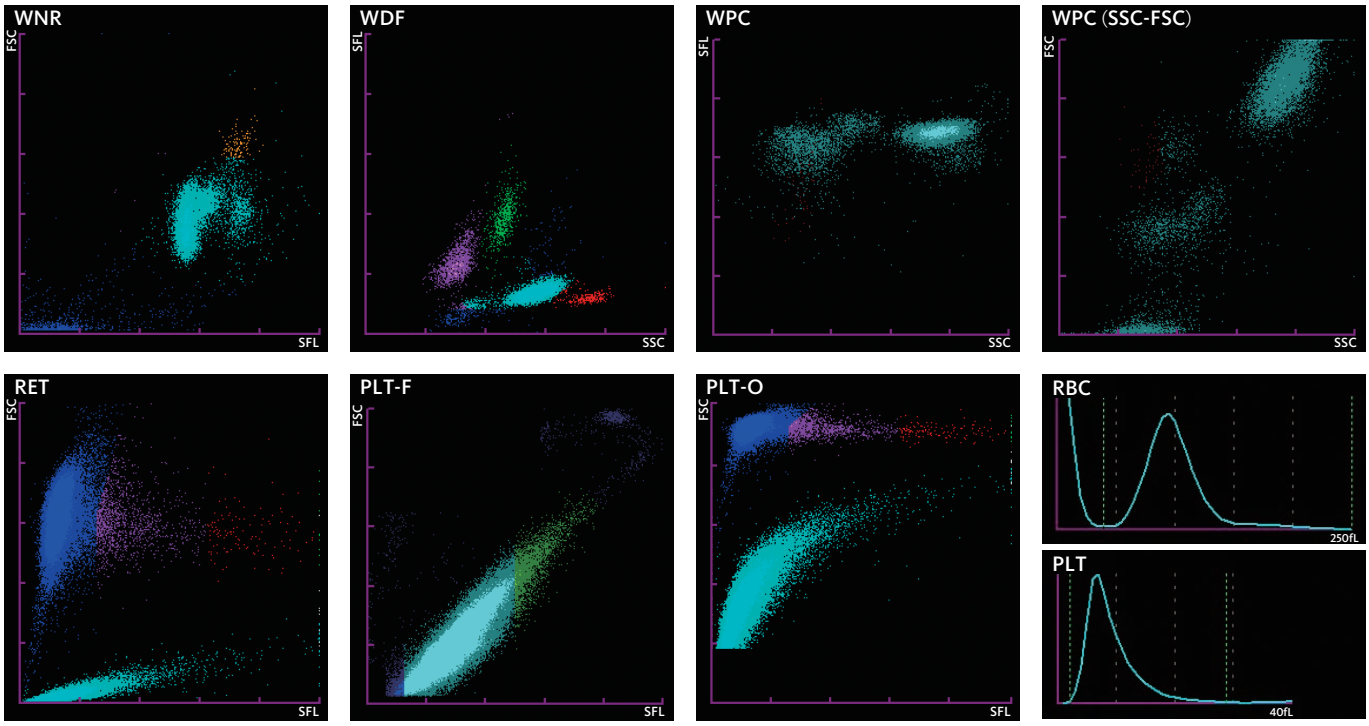
WBC	11.2	10^9/L		NEUT	8.57	10^9/L	+	76.4 % +
RBC	4.37	10^{12}/L		LYMPH	1.71	10^9/L		15.3 % –
HGB	119	g/L		MONO	0.51	10^9/L		4.6 %
HCT	0.413	L/L		EO	0.28	10^9/L		2.5 %
MCV	94.5	fL		BASO	0.13	10^9/L	+	1.2 % +
MCH	27.2	pg		IG	0.1	10^9/L		0.9 %
MCHC	288	g/L	–	RET	69.5	10^9/L		1.59 %
PLT	----	10^9/L		IRF	8.8	%		
RDW-SD	61.6	fL	+	LFR	91.2	%		
RDW-CV	17.8	%	+	MFR	7.6	%		
PDW	----	fL		HFR	1.2	%		
MPV	----	fL		RET-He	25.2	pg		
P-LCR	----	%		IPF	63.3	10^9/L	*	2.2 % *
PCT	----	L/L						
NRBC	0.0	10^9/L	0.0/100 WBC					

Flags

WBC Flag(s)

RBC Flag(s)
Hypochromia

PLT Flag(s)
Thrombocytosis
PLT Clumps?



Note

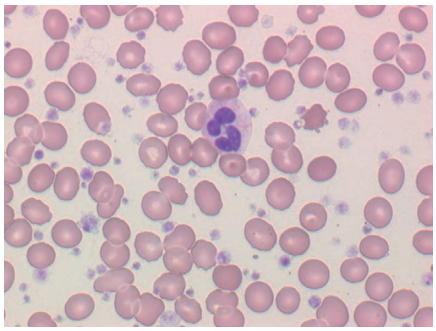
The platelet count is markedly high and platelet-related analysis parameters cannot be analyzed. The platelet aggregation seen in the smears is detected by the analyzer as reflected in the display of the “PLT Clumps?” flag.

Case history

A high platelet count was detected during a health checkup.

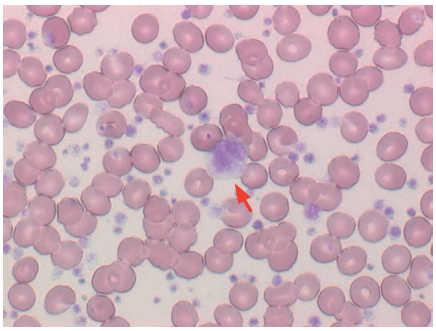
Blood smear (May-Giemsa staining)

PB



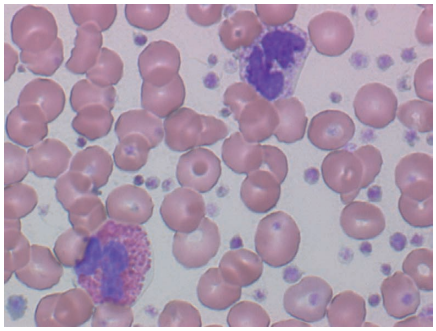
×400

PB



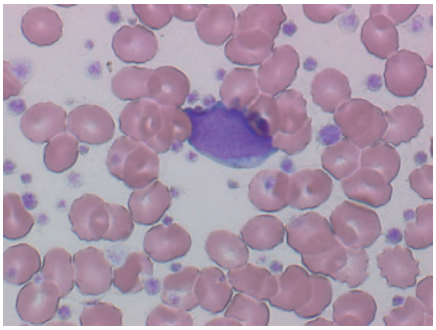
×400

PB



×600

PB



×600

Note

Peripheral blood shows a markedly high platelet count. Platelets are irregular in size, with some twice as large as red blood cells (⬆). There is a slight increase in white blood cell count with an increase in basophils (3%) (blastoid cells are also present). Bone marrow shows normoplasia with no abnormalities in differentiation and maturation or dysplasia in cells of the myeloid and erythroid series. Increased numbers of megakaryocytes and many sheet-like platelet aggregates are also seen (not presented here).
Based on the above, essential thrombocythemia is diagnosed.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	1.0
Meta	0.0
Stab	0.0
Segmented N.	82.0
Lymphocytes	11.0
Monocytes	2.0
Basophils	3.0
Eosinophils	1.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

Other tests

LD (U/L)
298(110-219)

unit : %

XN-Series

Abnormalities in the lymphoid lineage

B lymphoblastic leukemia/lymphoma (B-ALL)

Information from XN-Series

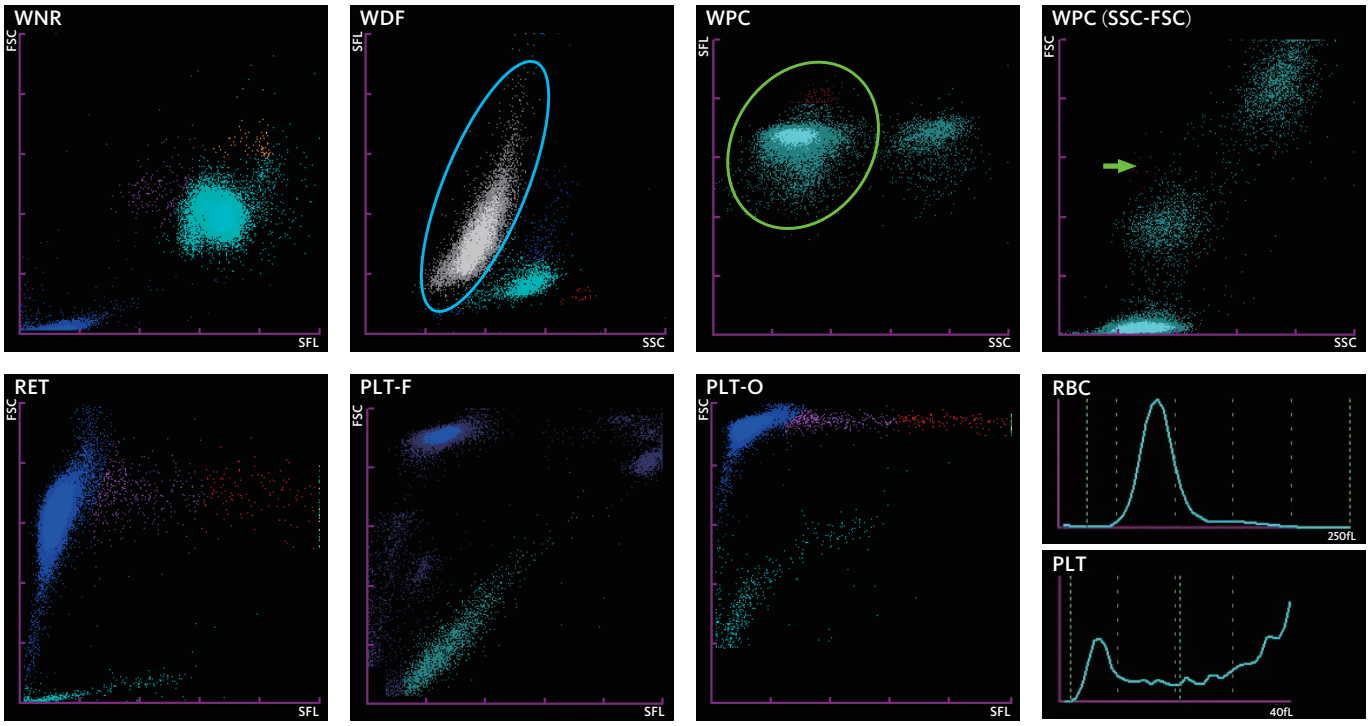
WBC	18.73	10^9/L	+	NEUT	3.63	10^9/L	*	19.3 % *
RBC	4.48	10^{12}/L		LYMPH	10.22	10^9/L	*	54.6 % *
HGB	121	g/L		MONO	4.77	10^9/L	*	25.5 % *
HCT	0.38	L/L		EO	0.02	10^9/L		0.1 %
MCV	84.8	fL	–	BASO	0.09	10^9/L		0.5 %
MCH	27.0	pg		IG	0.19	10^9/L		1.0 %
MCHC	318	g/L		RET	26.4	10^9/L		0.59 %
PLT	27	10^9/L	*	IRF	22.0	%		
RDW-SD	45.3	fL		LFR	78.0	%		
RDW-CV	15.0	%		MFR	16.1	%		
PDW	----	fL		HFR	5.9	%		
MPV	----	fL		RET-He	31.8	pg		
P-LCR	----	%		IPF	0.6	10^9/L		2.4 %
PCT	----	L/L						
NRBC	0.22	10^9/L	1.2/100 WBC					

Flags

WBC Flag(s)
- WBC Abn Scattergram
- Lymphocytosis
- Monocytosis
- Leukocytosis
- IG Present
- Blasts?

RBC Flag(s)

PLT Flag(s)
- PLT Abn Distribution
- Thrombocytopenia



Note

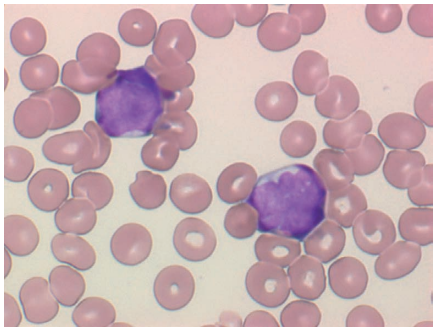
LYMPHO and MONO fractions cannot be separated on the WDF scattergram, and the cluster looks like a single population of cells (○). Based on comparison with the visual counts, it is assumed that normal lymphocytes, normal monocytes and blastoid cells form this cluster. Blastoid cells seem to be the main component of the ○ cluster on the WPC scattergram, and some cells are detected as abnormal cells in the WPC(SSC-FSC) scattergram (⬆, indicated in red). The “Blasts?” flag is also displayed.

Case history

The patient came for a checkup with gingival bleeding as the main complaint. A blood test revealed leukocytosis and thrombocytopenia.

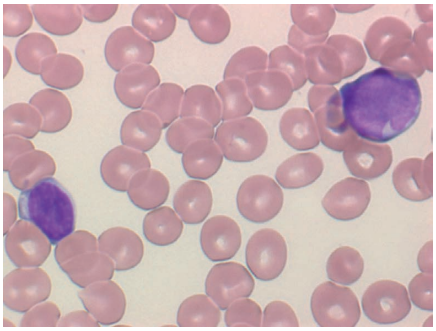
Blood smear (May-Giemsa staining)

PB



×600

PB



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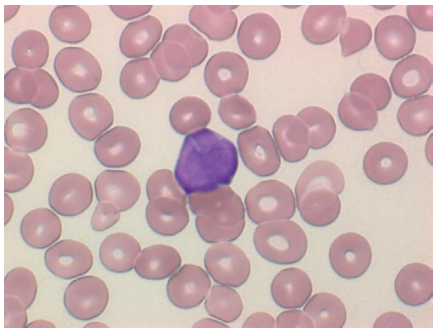
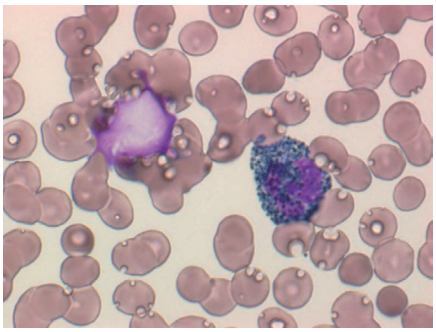
PB



×600

PB (Myeloperoxidase staining)



×600

Note

Peripheral blood shows leukocytosis and thrombocytopenia, with 75% blastoid cells. The blastoid cells are of medium size and have a high N/C ratio. Nuclei are somewhat irregular in shape with fine reticulated nuclear chromatin and indistinct nucleoli. These cells are negative on MPO staining.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	1.0
Meta	0.0
Stab	0.0
Segmented N.	12.0
Lymphocytes	11.0
Monocytes	1.0
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
Other*	75.0
NRBC	0.0/100 WBC

*Blastoid cells

Other tests

LD (U/L)
2049(110-219)

unit : %

Cell surface antigen expressions (PB)

T-Cell		**NK-Cell**	
CD2	10.7	CD16	2.5
CD3	12.1	CD56	1.5
CD4	6.3		
CD5	5.2	**Myeloid**	
CD7	11.4	CD13	2.4
CD8	5.2	CD14	0.7
		CD33	1.8
B-Cell			
CD10	86.2	**Other**	
CD19	82.2	CD25	2.1
CD20	23.8	CD34	0.4
CD22	86.6	CD38	95.8
CD23	2.7	CD45	99.0
cyCD79a	88.3	HLA-DR	92.3
κ	2.0	TdT	36.1
λ	2.5		
κ/λ	0.8		

unit : %

Note

The peripheral blood cells are positive for the B cell markers CD10, CD19, CD22 and cyCD79a. Expression of CD20 is weak. HLA-DR and TdT positivity is also detected. Based on the above, B-ALL is suspected.

T lymphoblastic lymphoma/leukemia (T-LBL)

Information from XN-Series

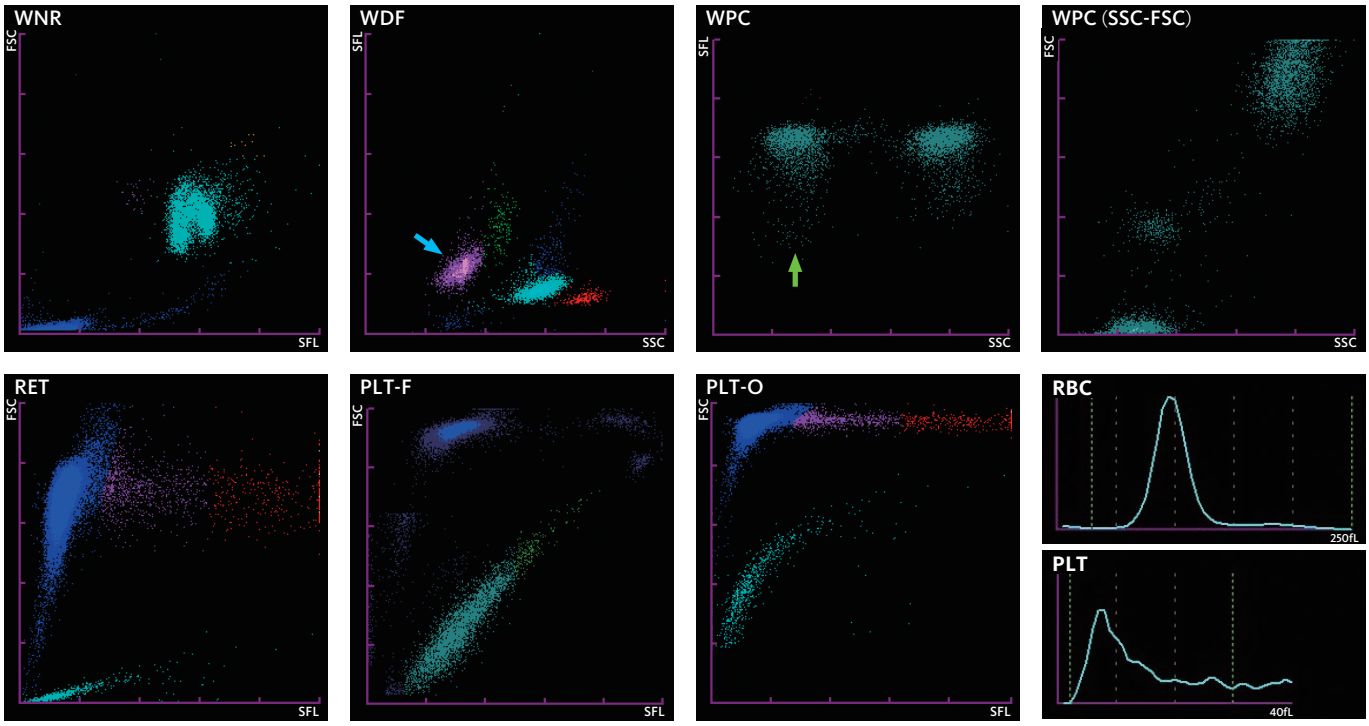
WBC	5.31	10^9/L		NEUT	2.71	10^9/L	*	51.1 %	*
RBC	5.04	10^{12}/L		LYMPH	2.20	10^9/L	*	41.4 %	*
HGB	156	g/L		MONO	0.14	10^9/L	*	2.6 %	*
HCT	0.481	L/L		EO	0.25	10^9/L		4.7 %	
MCV	95.4	fL		BASO	0.01	10^9/L		0.2 %	
MCH	31.0	pg		IG	0.23	10^9/L		4.3 %	
MCHC	324	g/L		RET	61	10^9/L		1.21 %	
PLT	55	10^9/L		IRF	27.7	%			
RDW-SD	43.9	fL		LFR	72.3	%			
RDW-CV	12.7	%		MFR	15.2	%			
PDW	19.3	fL	*	HFR	12.5	%			
MPV	13.3	fL	*	RET-He	33.0	pg			
P-LCR	45.4	%	*	IPF	2.0	10^9/L		4.8 %	
PCT	0.0007	L/L	*						
NRBC	0.03	10^9/L	0.6/100 WBC						

Flags

WBC Flag(s)
IG Present
Abn Lympho?

RBC Flag(s)

PLT Flag(s)
PLT Abn Distribution
Thrombocytopenia



Note

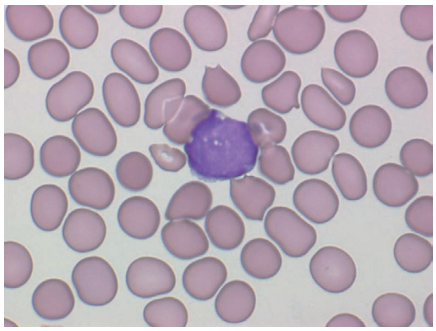
Although the white blood cell count is within the normal range, the LYMPH cluster is plotted on the WDF scattergram in a low fluorescence intensity region, and its shape is abnormal (⬆). Based on comparison with the visual counts, the medium-sized abnormal cells of lymphoid lineage seen in the smears seem to have been plotted in the LYMPH cluster along with normal lymphocytes (⬆). The cluster corresponding to lymphocytes spreads downwards on the WPC scattergram (⬆). The size, position of the center of mass and shape of the LYMPH cluster on the WDF scattergram are comprehensively analyzed, and the “Abn Lympho?” flag is displayed.

Case history

The case had been diagnosed as T-LBL by lymph node biopsy. Abnormal lymphocytes were seen in peripheral blood during treatment.

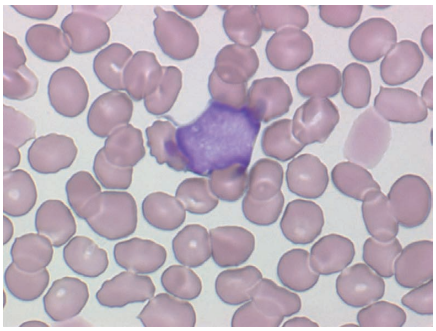
Blood smear (May-Giemsa staining)

PB



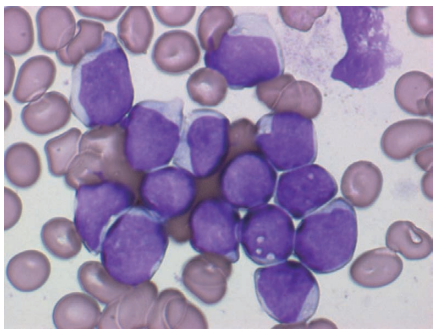
×600

PB



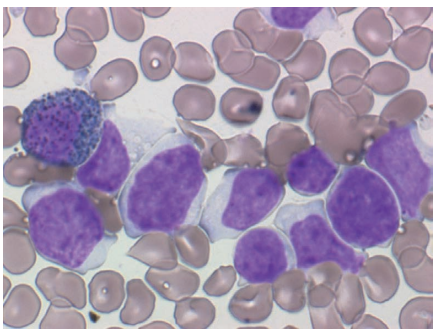
×600

BM



×600

BM (Myeloperoxidase staining)



×600

Note

Peripheral blood shows thrombocytopenia and has 21% abnormal lymphocytes (later shown to be lymphoblasts, see below). The abnormal lymphocytes are medium in size with high N/C ratio. Nuclei are round and nuclear chromatin is finer with less clumping than in mature lymphocytes. Nucleoli are visible.
Bone marrow shows hyperplasia with 85.4% abnormal lymphocytes. Nuclei of abnormal lymphocytes are partially irregular in shape and the cells have vacuoles. The cells are MPO negative.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	3.5
Meta	4.5
Stab	3.5
Segmented N.	44.0
Lymphocytes	16.0
Monocytes	3.5
Basophils	0.0
Eosinophils	3.5
Atypical Lymph	0.5
Other*	21.0
NRBC	1.0/100 WBC

*Abnormal lymphocytes

Other tests

LD (U/L)
231(110-219)
sIL-2R (U/mL)
719(145-519)

BM

NCC (×10⁴/μL)	30.9
Megakaryo (/μL)	<15
Myeloblast	0.0
Promyelo	0.0
Myelo	2.9
Meta	1.4
Stab	0.9
Segmented N.	1.6
Eosinophils	0.6
Basophils	0.0
Lymphocytes	1.1
Monocytes	0.6
Plasma	0.0
Macrophage	0.0
Megakaryo	0.0
Other*	85.4
Pro Erythroblast	0.0
Baso Erythroblast	0.1
Poly Erythroblast	5.4
Orth Erythroblast	0.0
M:E ratio	1.3
MPO staining	Blast<3%

*Abnormal lymphocytes

Chromosome analysis

G-band 46,XY [20]

unit : %

Cell surface antigen expressions (BM)

T-Cell		NK-Cell	
CD1a	1.3	CD16	0.4
CD2	2.1	CD56	0.4
CD3	98.7		
CD4	0.8	**Myeloid**	
CD5	1.5	CD13	12.7
CD7	99.5	CD14	0.2
CD8	1.5	CD33	0.3
TCRα/β	1.2		
TCRγ/δ	97.9	**Other**	
		CD25	0.9
B-Cell		CD34	0.8
CD10	0.4	CD38	99.9
CD19	0.3	CD45	99.8
CD20	0.4	HLA-DR	8.4
CD22	0.9	TdT	35.1
cyCD79a	0.5		

unit : %

Note

The bone marrow cells are positive for the T-cell markers CD3, CD7 and TCRγ/δ. TdT is also expressed, demonstrating that the abnormal lymphocytes are, in fact, lymphoblasts.
Based on cell morphology and surface marker test results, this is considered to be a case of leukemic transformation of T-LBL.

B-cell chronic lymphocytic leukemia/lymphoma (B-CLL)

Information from XN-Series

WBC	195.72	10^9/L	+	NEUT	2.51	10^9/L	* 1.2 % *
RBC	3.42	10^{12}/L		LYMPH	190.28	10^9/L	* 97.2 % *
HGB	109	g/L		MONO	1.34	10^9/L	* 0.7 % *
HCT	0.374	L/L		EO	0.12	10^9/L	0.1 %
MCV	109.4	fL		BASO	1.47	10^9/L	+ 0.8 %
MCH	31.9	pg		IG	0.16	10^9/L	0.1 %
MCHC	291	g/L	–	RET	24.6	10^9/L	0.72 %
PLT	131	10^9/L		IRF	11.8	%	
RDW-SD	57.4	fL	+	LFR	88.2	%	
RDW-CV	14.5	%		MFR	10.4	%	
PDW	11.5	fL		HFR	1.4	%	
MPV	10.3	fL		RET-He	33.4	pg	
P-LCR	26.8	%		IPF	3.6	10^9/L	2.7 %
PCT	0.0013	L/L	–				
NRBC	0.14	10^9/L	0.1/100 WBC				

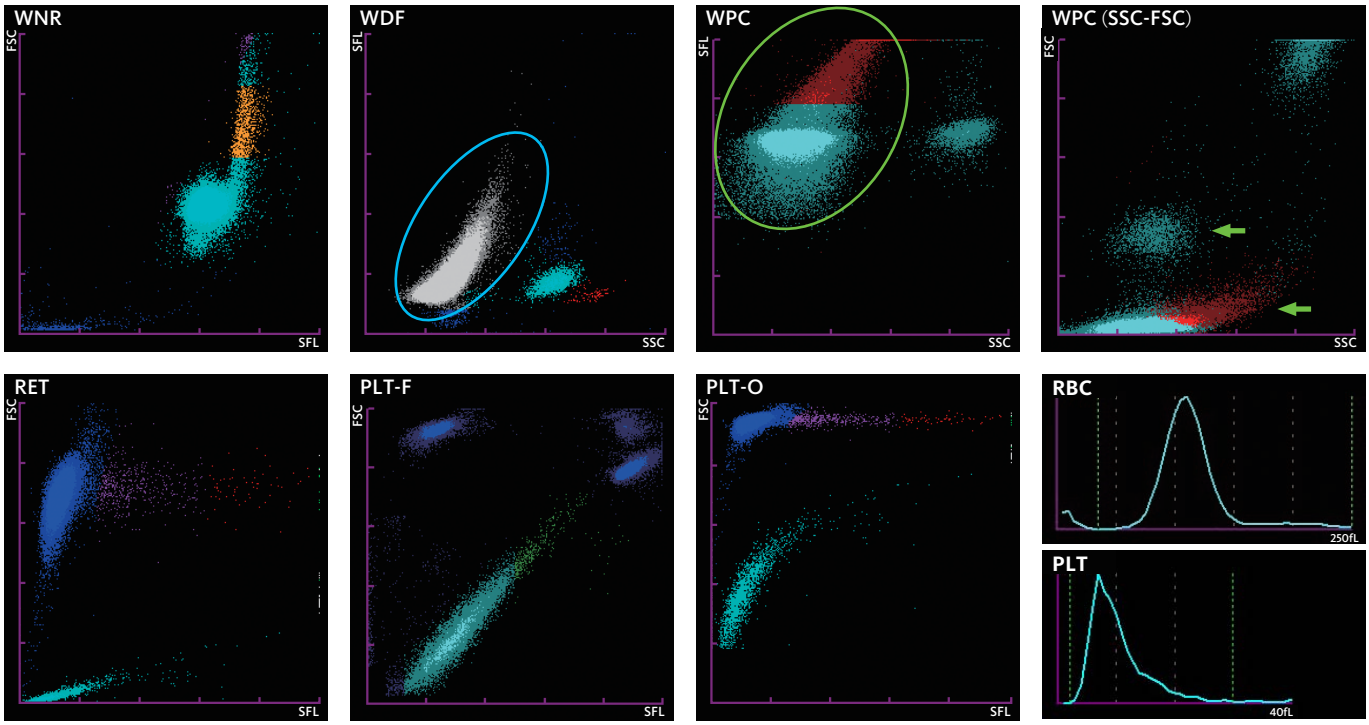
Flags

WBC Flag(s)

WBC Abn Scattergram
Lymphocytosis
Monocytosis
Basophilia
Leukocytosis
IG Present
Abn Lympho?

RBC Flag(s)

PLT Flag(s)



Note

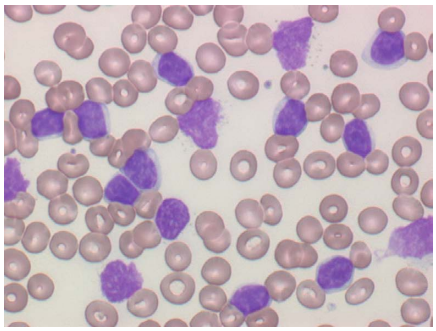
The white blood cell count is markedly high, and LYMPH and MONO fractions cannot be separated on the WDF scattergram. In the visual count, abnormal cells of the lymphoid lineage constitute 93% and form the cluster (○) in the LYMPH/MONO area on the WDF scattergram and the ○ cluster on the WPC scattergram. These cells are generally uniform in morphology in the smears, and a part of these abnormal cell populations are detected as abnormal cells in the WPC scattergram (indicated in red). In addition, the balance between the two clusters corresponding to lymphocytes on the WPC (SSC-FSC) scattergram (⬆) is very different from that of the normal pattern (the lower cluster is larger in proportion), and some cells are detected as abnormal cells. The “Abn Lympho?” flag is displayed.

Case history

A marked increase in white blood cell count was detected during a health checkup and the patient was referred to our hospital.

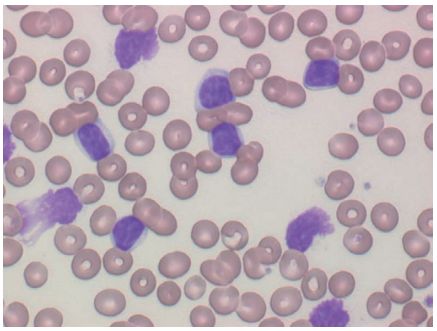
Blood smear (May-Giemsa staining)

PB



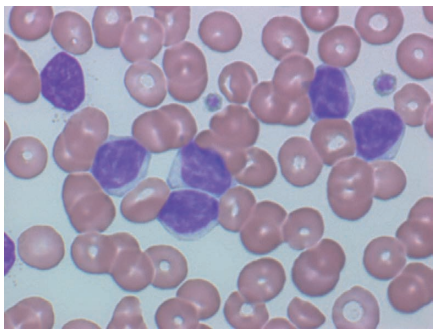
×400

PB



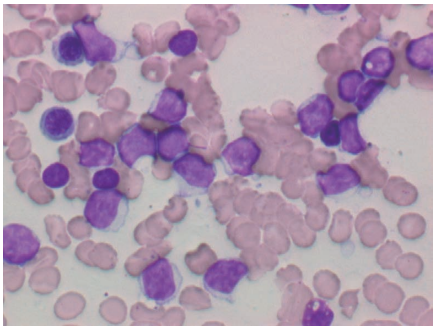
×400

PB



×600

BM



×400

Note

Peripheral blood shows leukocytosis and anemia, and mature lymphocytes are increased (93%). The size of the lymphocytes is about twice that of red blood cells, and they have scanty cytoplasme which is weakly basophilic. Nuclei are round in shape with clumped nuclear chromatin. Nucleoli are indistinct. There are also numerous smudge cells present in the sample.
Bone marrow shows hyperplasia and an increase in mature lymphocytes (70.4%), similar to the findings in peripheral blood.

Visual differential counts

PB	
Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	0.0
Segmented N.	7.0
Lymphocytes*	93.0
Monocytes	0.0
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

*Lymphoid cells

Other tests

LD (U/L)
218(110-219)

sIL-2R (U/mL)
2130(145-519)

BM			
NCC (×10⁴/μL)	10.8	Pro Erythroblast	0.0
Megakaryo (/μL)	<15	Baso Erythroblast	0.5
Myeloblast	0.6	Poly Erythroblast	10.5
Promyelo	0.1	Orth Erythroblast	0.0
Myelo	3.8	M:E ratio	4.0
Meta	1.5		
Stab	3.8		
Segmented N.	5.8		
Eosinophils	0.5		
Basophils	0.0		
Lymphocytes*	70.4		
Monocytes	0.9		
Plasma	1.6		
Macrophage	0.0		
Megakaryo	0.0		

*Lymphoid cells

unit : %

Cell surface antigen expressions (BM)

T-Cell		NK-Cell	
CD2	4.1	CD16	3.2
CD3	1.6	CD56	2.1
CD4	1.1		
CD5	51.1	**Myeloid**	
CD7	3.4	CD13	1.4
CD8	1.7	CD14	0.4
		CD33	0.2
B-Cell			
CD10	0.0	**Other**	
CD19	95.6	CD25	7.4
CD20	87.6	CD34	0.2
CD22	88.9	CD38	3.3
CD23	72.7	CD45	100.0
κ	0.1	HLA-DR	96.5
λ	46.5		
κ/λ	0.0		

unit : %

Note

The bone marrow cells are positive for the B-cell markers CD19, CD20, CD22 and CD23, and λ restriction is observed, thereby confirming clonality. Expression of T-cell marker CD5 is also noted. Based on the above, B-CLL is suspected.

Hairy cell leukemia (HCL)

Information from XN-Series

WBC	14.66	10^9/L		NEUT	3.39	10^9/L	23.1 % –
RBC	4.67	10^{12}/L		LYMPH	9.53	10^9/L	* 65.0 % *
HGB	138	g/L		MONO	1.54	10^9/L	* 10.5 % *
HCT	0.437	L/L		EO	0.11	10^9/L	0.8 %
MCV	93.6	fL		BASO	0.09	10^9/L	0.6 %
MCH	29.6	pg		IG	0.03	10^9/L	0.2 %
MCHC	316	g/L		RET	44.8	10^9/L	0.96 %
PLT	182	10^9/L		IRF	4.9	%	
RDW-SD	44.6	fL		LFR	95.1	%	
RDW-CV	12.9	%		MFR	4.7	%	
PDW	12.9	fL		HFR	0.2	%	
MPV	10.9	fL		RET-He	33.1	pg	
P-LCR	32.4	%		IPF	5.8	10^9/L	3.3 %
PCT	0.002	L/L					
NRBC	0.0	10^9/L	0.0/100 WBC				

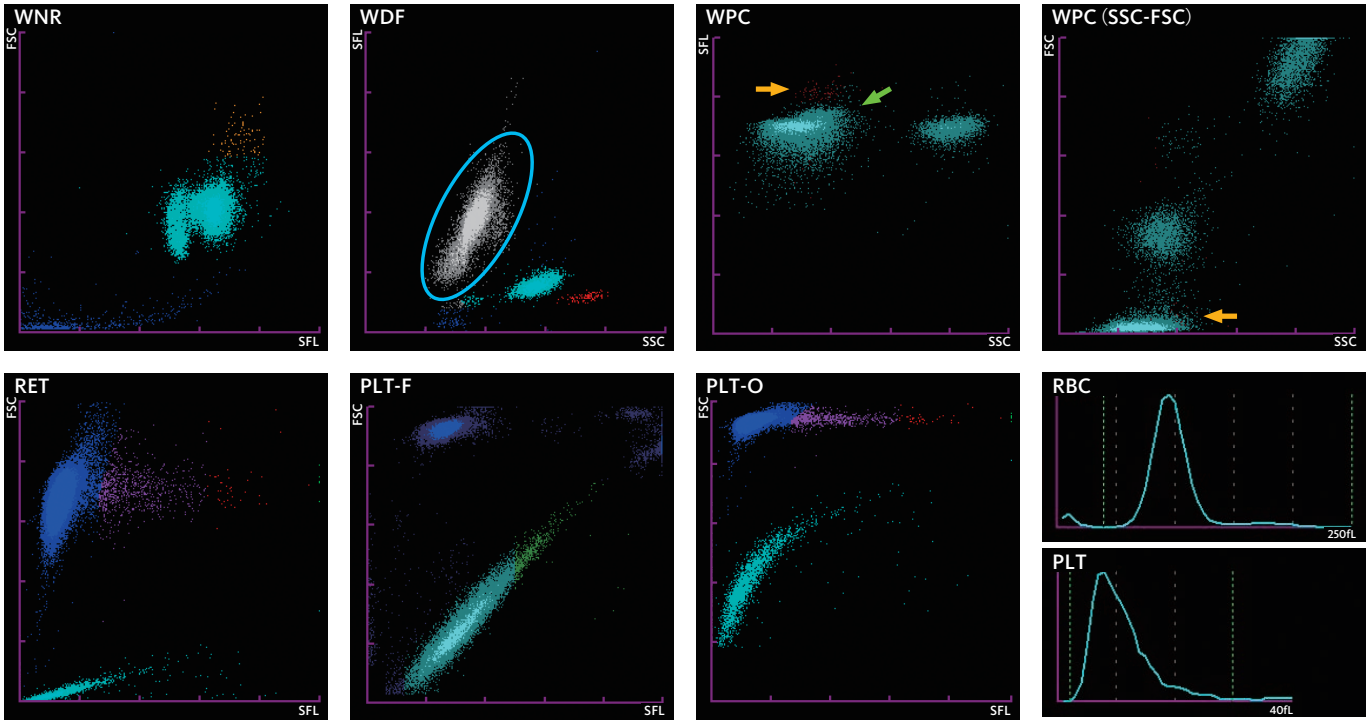
Flags

WBC Flag(s)

WBC Abn Scattergram
Lymphocytosis
Monocytosis
Abn Lympho?

RBC Flag(s)

PLT Flag(s)



Note

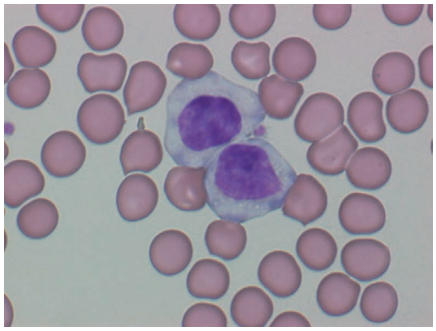
LYMPH and MONO fractions cannot be separated on the WDF scattergram (○). It is likely that the HCL-like cells seen in large numbers in the smear have formed the ○ cluster. The cluster corresponding to lymphocytes extends slightly upward on the WPC scattergram (↑) and some cells are detected as abnormal cells in the WPC and WPC(SSC-FSC) scattergrams (↑). The “Abn Lympho?” flag is also displayed.

Case history

Leukocytosis was detected during a health checkup.

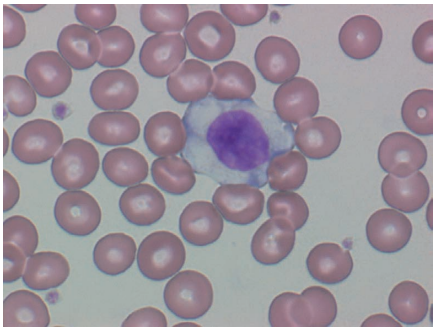
Blood smear (May-Giemsa staining)

PB



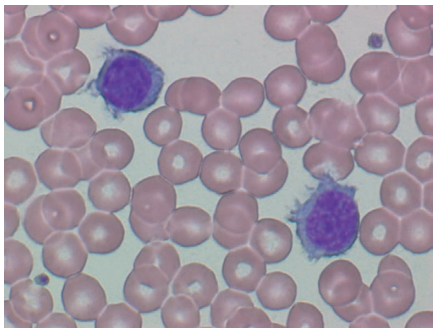
×600

PB



×600

PB (air-dried sample)



×600

Note

Peripheral blood shows an increase in the white blood cell count and 86.5% abnormal lymphocytes. The abnormal lymphocytes are medium in size with low N/C ratio and a abundant cytoplasm. The cytoplasmic margins are irregular. Nuclei are centrally located and are round in shape with coarse nuclear chromatin.
In the air-dried samples, hair-like projections are seen all around the cell margin.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	0.0
Segmented N.	11.5
Lymphocytes	0.5
Monocytes	2.0
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
Other*	86.0
NRBC	0.0/100 WBC

*HCL-like cells

Other tests

LD (U/L)
2049(110-219)

unit : %

Cell surface antigen expressions (PB)

T-Cell	
CD2	16.5
CD3	11.3
CD4	5.2
CD5	13.2
CD7	15.2
CD8	8.1
B-Cell	
CD10	0.2
CD19	78.8
CD20	73.3
CD22	77.6
CD23	0.8
κ	0.6
λ	0.4
κ/λ	1.0
NK-Cell	
CD16	8.6
CD56	8.7
Myeloid	
CD13	2.4
CD14	2.2
CD33	3.1
Other	
CD11c	78.5
CD25	5.2
CD34	0.5
CD38	13.2
CD45	99.9
CD103	73.2
FMC7	74.8
HLA-DR	83.8

unit : %

Note

The cells are positive for the B-cell markers CD19, CD20 and CD22 and negative for Ig light chain (IgL chain) expressed on the cell surface. Apart from this, there is positivity for CD11c, CD103 and FMC7 as well. Based on the above, HCL is diagnosed.

Plasma cell myeloma

Information from XN-Series

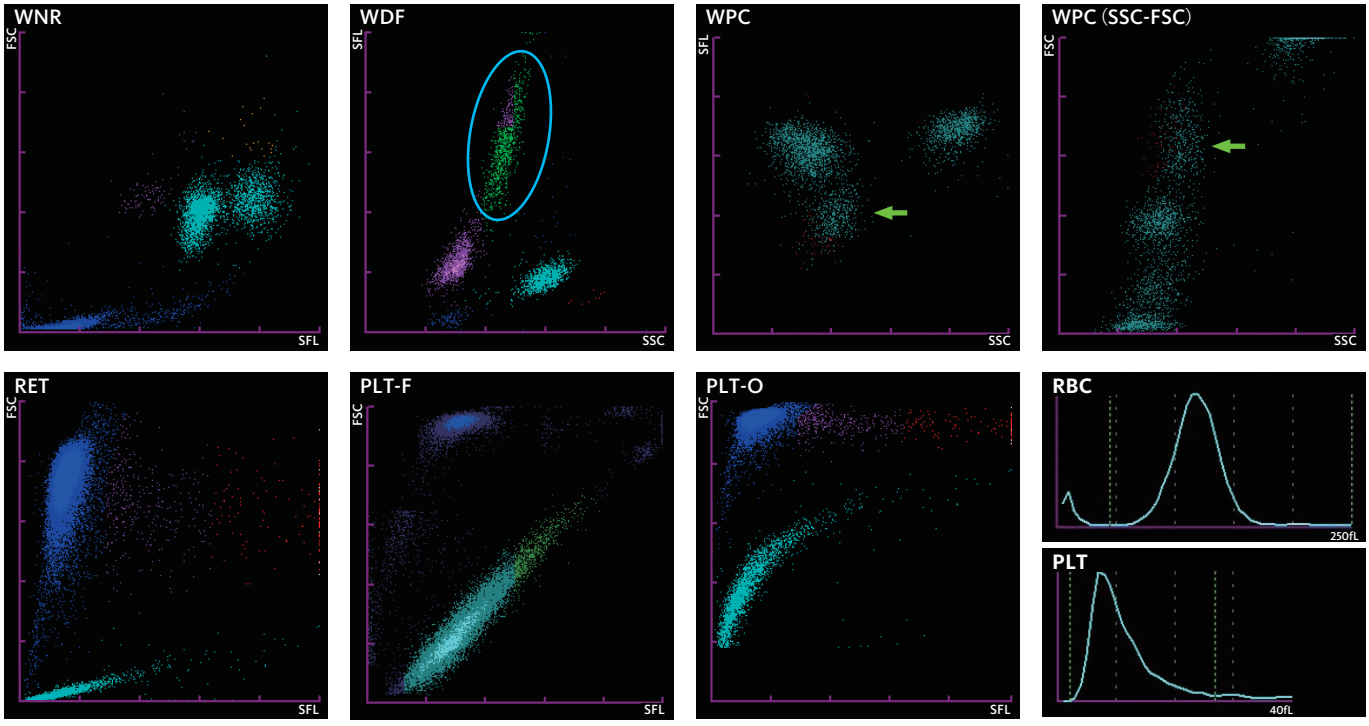
WBC	3.81	10^9/L		NEUT	1.41	10^9/L	*	37.0 % *
RBC	2.52	10^{12}/L		LYMPH	1.68	10^9/L	*	44.1 % *
HGB	93	g/L		MONO	0.69	10^9/L	*	18.1 % *
HCT	0.291	L/L		EO	0.01	10^9/L		0.3 %
MCV	115.5	fL	+	BASO	0.02	10^9/L		0.5 %
MCH	36.9	pg		IG	0.03	10^9/L		0.8 %
MCHC	320	g/L		RET	22.7	10^9/L		0.90 %
PLT	164	10^9/L		IRF	26.4	%		
RDW-SD	62.7	fL	+	LFR	73.6	%		
RDW-CV	14.7	%		MFR	13.2	%		
PDW	12.3	fL		HFR	13.2	%		
MPV	10.8	fL		RET-He	28.8	pg		
P-LCR	31.1	%		IPF	7.2	10^9/L		4.2 %
PCT	0.0018	L/L						
NRBC	0.1	10^9/L	2.6/100 WBC					

Flags

WBC Flag(s)
NRBC Present
Blasts?

RBC Flag(s)
Macrocytosis
Anemia

PLT Flag(s)



Note

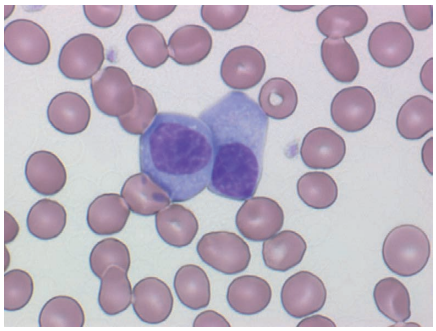
The MONO cluster (○) appears in an area with a higher fluorescence intensity than is normal in the WDF scattergram. Since monocytes comprise 1% in the visual count, it is likely that the plasma-like cells seen in the smears are forming this cluster. There are also plots not observed in normal samples in the WPC and WPC (SSC-FSC) scattergrams (⬆), and plasma-like cells seem to have been plotted in this area.

Case history

Abnormal lymphocytes were seen in peripheral blood.

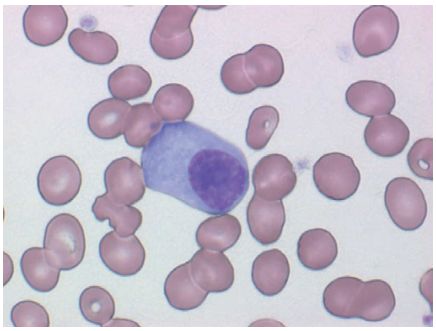
Blood smear (May-Giemsa staining)

PB



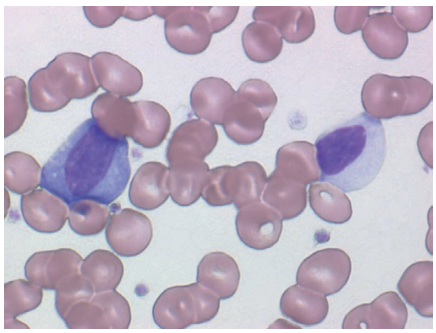
×600

PB



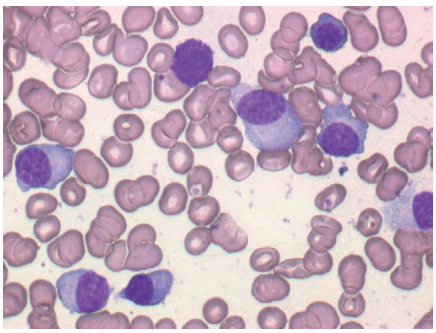
×600

PB



×600

BM



×400

Note

Peripheral blood shows anemia and 29% abnormal lymphocytes. The abnormal lymphocytes are medium to large in size with a low N/C ratio and strongly basophilic cytoplasm. Nuclei are eccentrically located, and coarse clumping of the chromatin is seen. Cells with nucleoli are also seen. Based on these characteristics, these abnormal lymphocytes are considered to be plasma cells.
Bone marrow shows hypoplasia and an increase in plasma cells (53.1%).

Visual differential counts

PB	
Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	3.0
Segmented N.	31.0
Lymphocytes	36.0
Monocytes	1.0
Basophils	0.0
Eosinophils	0.0
Atypical Lymph	0.0
Other*	29.0
NRBC	2.0/100 WBC

*Plasma-like cells

BM	
NCC (×10⁴/μL)	3.5
Megakaryo (/μL)	<15
Myeloblast	0.0
Promyelo	0.2
Myelo	3.9
Meta	1.8
Stab	2.2
Segmented N.	6.5
Eosinophils	0.2
Basophils	0.0
Lymphocytes	11.5
Monocytes	0.3
Plasma	53.1
Macrophage	0.0
Megakaryo	0.1
Pro Erythroblast	0.0
Baso Erythroblast	0.5
Poly Erythroblast	19.7
Orth Erythroblast	0.0
M:E ratio	0.7

Chromosome analysis
G-band 46,XY [20]

Other tests

LD (U/L)	218(110-219)
TP (g/dL)	7.9(6.5-8.0)
IgG (mg/dL)	651(870-1700)
IgA (mg/dL)	11(110-350)
IgM (mg/dL)	10(30-180)

unit : %

Cell surface antigen expressions

B-Cell	
CD19	0.1
CD20	1.3
cyκ	99.0
cyλ	0.1
κ/λ	990.0

NK-Cell	
CD56	88.7

Myeloid	
CD13	55.8
CD33	3.8

Other	
CD45	2.3
CD49e	0.3
CD138	99.0

CD38 gating

unit : %

Note

CD13, CD56 and CD138-positivity are seen on CD38 gating. Clonality on the basis of κ chain dominance is seen in the cytoplasmic Ig light chain. The cells are CD19-negative. Based on the above, the condition is diagnosed as plasma cell myeloma.

Follicular lymphoma

Information from XN-Series

WBC	7.69	10^9/L		NEUT	2.54	10^9/L	* 33.0 % *
RBC	4.69	10^{12}/L		LYMPH	4.70	10^9/L	* 61.1 % *
HGB	142	g/L		MONO	0.29	10^9/L	* 3.8 % *
HCT	0.447	L/L		EO	0.07	10^9/L	0.9 %
MCV	95.3	fL		BASO	0.09	10^9/L	1.2 % +
MCH	30.3	pg		IG	0.01	10^9/L	0.1 %
MCHC	318	g/L		RET	46.4	10^9/L	0.99 %
PLT	137	10^9/L		IRF	6.8	%	
RDW-SD	44.0	fL		LFR	93.2	%	
RDW-CV	12.6	%		MFR	5.8	%	
PDW	12.0	fL		HFR	1.0	%	
MPV	10.4	fL		RET-He	33.1	pg	
P-LCR	27.3	%		IPF	2.5	10^9/L	1.9 %
PCT	0.0014	L/L	–				
NRBC	0.01	10^9/L	0.1/100 WBC				

Flags

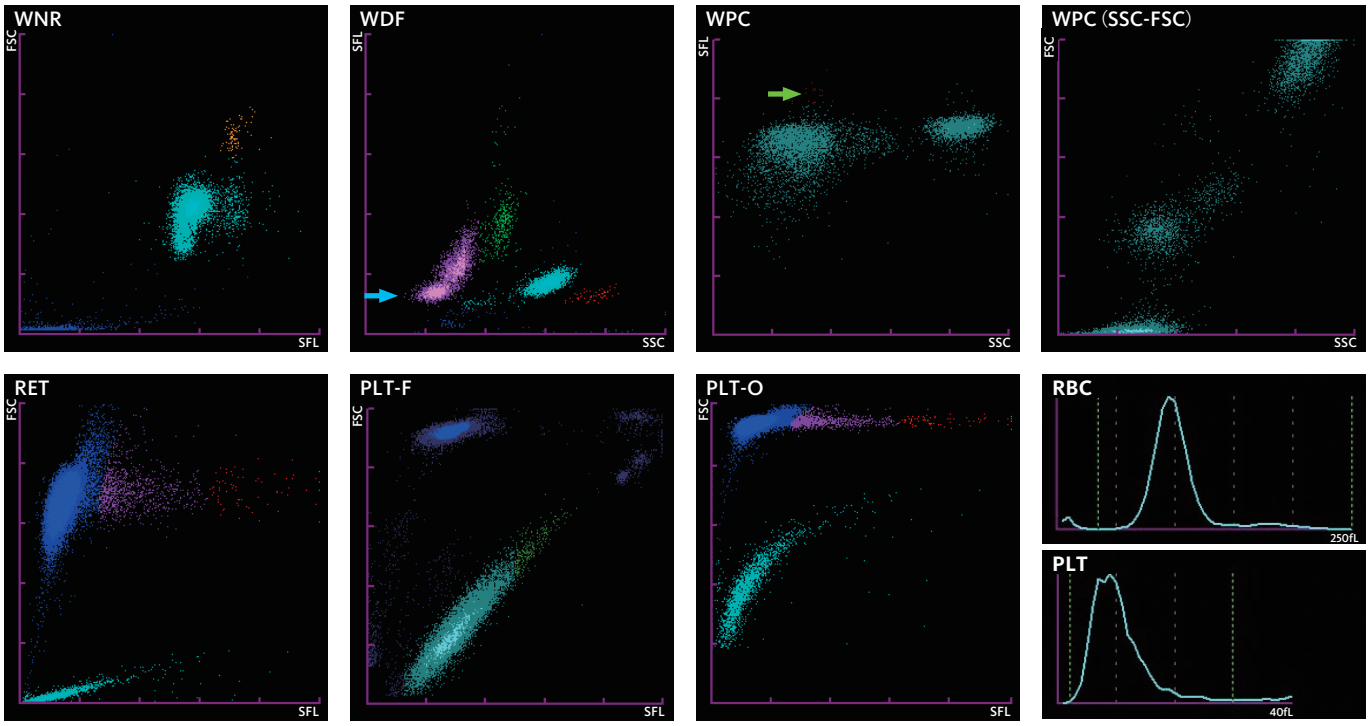
WBC Flag(s)

Lymphocytosis

Abn Lympho?

RBC Flag(s)

PLT Flag(s)



Note

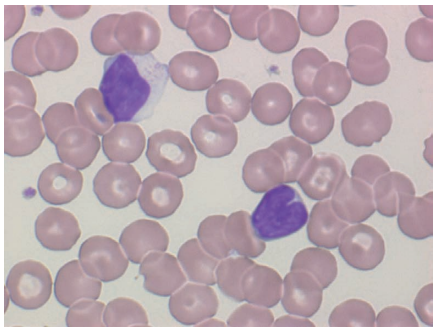
The LYMPHO cluster (indicated in pink) on the WDF scattergram shows a bimodal distribution. Based on comparison with the normal scattergram pattern, abnormal cells of the lymphoid lineage seen in the smears seem to form the ⬆ cluster (lower). Some cells are detected as abnormal cells, and they are plotted in the upper area of the cluster corresponding to lymphocytes on the WPC scattergram (⬆, indicated in red). The “Abn Lympho?” flag is displayed based on a comprehensive analysis of the size, center of mass and shape of the LYMPH cluster on the WDF scattergram.

Case history

The patient visited a clinic because of diarrhea, and a blood test revealed abnormal lymphocytes.

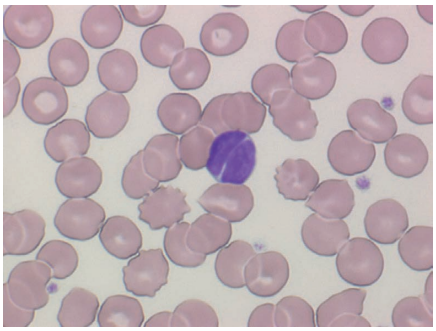
Blood smear (May-Giemsa staining)

PB



×600

PB



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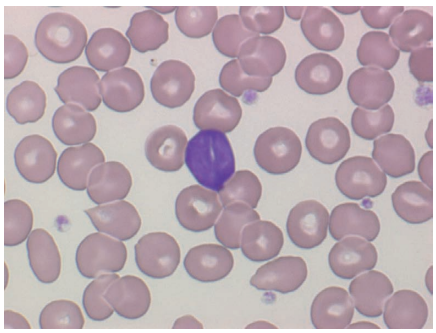
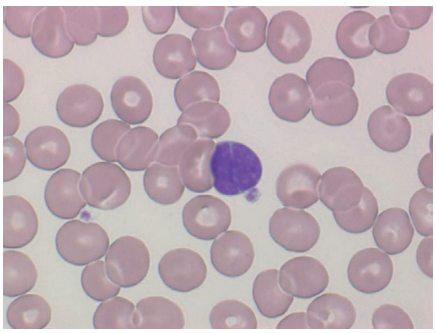
PB



×600

PB



×600

Note

No clear abnormality is observed in the peripheral blood cell count. However, 39% abnormal lymphocytes are seen in peripheral blood smears. The abnormal lymphocytes are smaller than mature lymphocytes. The N/C ratio is extremely high with only scanty cytoplasm present. The nuclei show a prominence of cleaving and coarse nuclear chromatin.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	0.0
Segmented N.	29.0
Lymphocytes	26.0
Monocytes	5.0
Basophils	0.0
Eosinophils	1.0
Atypical Lymph	0.0
Other*	39.0
NRBC	0.0/100 WBC

*Abnormal lymphocytes

Other tests

LD (U/L)
177(110-219)

sIL-2R (U/mL)
899(145-519)

unit : %

Cell surface antigen expressions (PB)

T-Cell	
CD2	3.1
CD3	2.7
CD4	1.6
CD5	3.9
CD7	2.5
CD8	0.4
B-Cell	
CD10	81.0
CD19	96.0
CD20	88.0
CD22	95.9
CD23	52.3
κ	90.1
λ	0.5
κ/λ	180.2
NK-Cell	
CD16	0.7
CD56	0.6
Myeloid	
CD14	0.3
Other	
CD25	13.3
CD34	0.2
HLA-DR	96.1

unit : %

Note

The cells are positive for the B-cell markers CD10, CD19, CD20, CD22 and CD23, and clonality with κ chain dominance of the Ig light chain is seen.
FL is diagnosed based on lymph node biopsy. Based on the above, this is considered to be a case of leukemic transformation of FL.

Diffuse large B-cell lymphoma (DLBCL)

Information from XN-Series

WBC	5.91	10^9/L	
RBC	2.49	10^{12}/L	–
HGB	85	g/L	
HCT	0.283	L/L	
MCV	113.7	fL	+
MCH	34.1	pg	
MCHC	300	g/L	–
PLT	40	10^9/L	
RDW-SD	80.1	fL	+
RDW-CV	19.0	%	+
PDW	14.9	fL	
MPV	12.1	fL	
P-LCR	39.7	%	
PCT	0.0005	L/L	–
NRBC	0.0	10^9/L	0.0/100 WBC

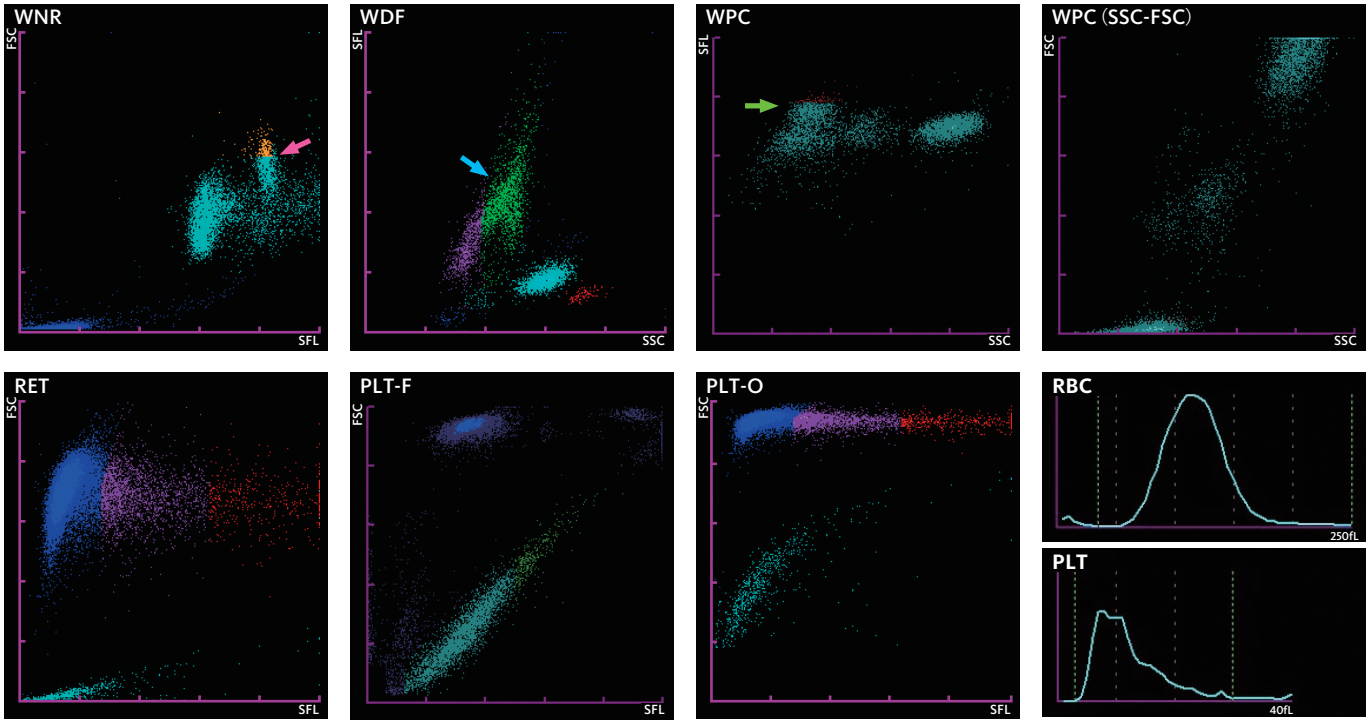
NEUT	3.10	10^9/L	*	52.4 %	*
LYMPH	0.92	10^9/L	*	15.6 %	*
MONO	1.54	10^9/L	*	26.1 %	*
EO	0.10	10^9/L		1.7 %	
BASO	0.25	10^9/L	+	4.2 %	+
IG	0.06	10^9/L		1.0 %	
RET	123.5	10^9/L		4.96 %	
IRF	15.9	%			
LFR	84.1	%			
MFR	10.5	%			
HFR	5.4	%			
RET-He	30.9	pg			
IPF	2.9	10^9/L		7.5 %	

Flags

WBC Flag(s)
Monocytosis
Basophilia
Blasts?

RBC Flag(s)
Anisocytosis
Macrocytosis
Anemia

PLT Flag(s)
Thrombocytopenia



Note

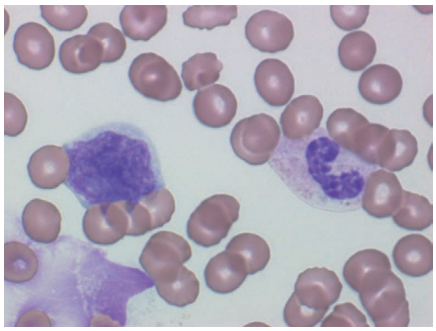
While 0% basophils are found in the visual apparently, medium to large abnormal cells are plotted in the BASO area of the WNR scattergram (⬆). Separation of the LYMPHO and MONO clusters is unclear on the WDF scattergram, and the 5-part differential white blood cell data varied markedly from the visual counts. Based on comparison with visual counts, the medium to large abnormal cells seen in smears seem to correspond to ⬆ (indicated in green), and they form a continuous cluster together with the lymphocytes. Two clusters corresponding to lymphocytes are seen in the WPC scattergram, and the abnormal cells seem to form the upper cluster (⬆), based on comparison with the normal scattergram pattern.

Case history

A case diagnosed as DLBCL after lymph node biopsy. Abnormal cells are seen in peripheral blood.

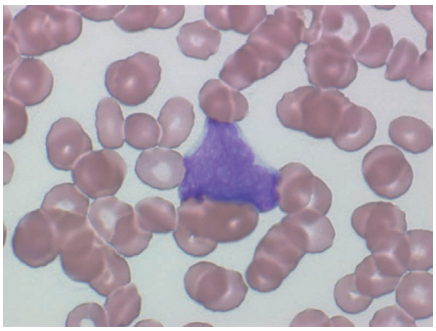
Blood smear (May-Giemsa staining)

PB



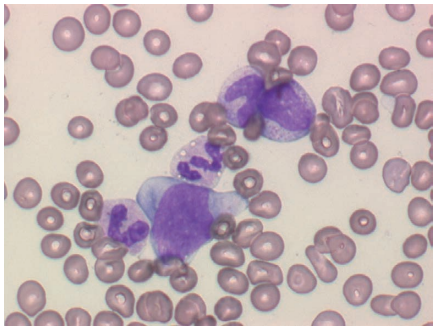
×600

PB



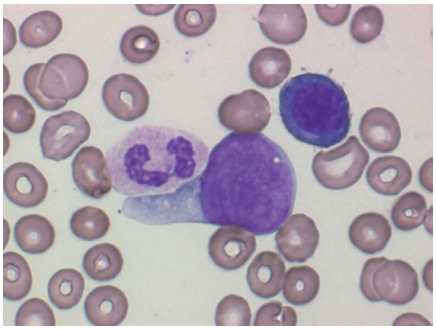
×600

BM



×400

BM



×600

Note

Peripheral blood shows anemia and thrombocytopenia, and displays 3% abnormal cells. These cells are medium to large in size with high N/C ratio. Nuclei are irregular in shape with coarse nuclear chromatin and several nucleoli.
Bone marrow shows normoplasia and has only 2.4% abnormal cells. These are large and have abundant cytoplasm. Cells with cytoplasmic extensions in the shape of pseudopodia are also seen.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	2.0
Segmented N.	86.0
Lymphocytes	4.0
Monocytes	3.0
Basophils	0.0
Eosinophils	2.0
Atypical Lymph	0.0
Other*	3.0
NRBC	0.0/100 WBC

*Atypical cells

Other tests

LD (U/L)
769(110-219)
sIL-2R (U/mL)
11700(145-519)

BM

NCC (×10⁴/μL)	5.2
Megakaryo (/μL)	<15
Myeloblast	0.7
Promyelo	0.8
Myelo	7.9
Meta	3.3
Stab	6.2
Segmented N.	14.5
Eosinophils	2.6
Basophils	0.2
Lymphocytes	7.0
Monocytes	3.0
Plasma	0.6
Macrophage	1.3
Megakaryo	0.2
Other*	2.4

Pro Erythroblast	0.2
Baso Erythroblast	1.6
Poly Erythroblast	47.5
Orth Erythroblast	0.0
M:E ratio	0.7

*Abnormal cells

Chromosome analysis

G-band 46,XY [20]

unit : %

Cell surface antigen expressions

T-Cell	
CD5	87.3
B-Cell	
CD10	0.8
CD19	85.3
CD23	1.0
κ	0.1
λ	83.0
κ/λ	0.0

CD20 gating

unit : %

Note

CD5 and CD19 are found to be expressed on CD20 gating and clonality with dominance of the λ Ig light chain is evident.
Based on the above, leukemic transformation of DLBCL is diagnosed.

Adult T-cell leukemia/lymphoma (ATLL)

Information from XN-Series

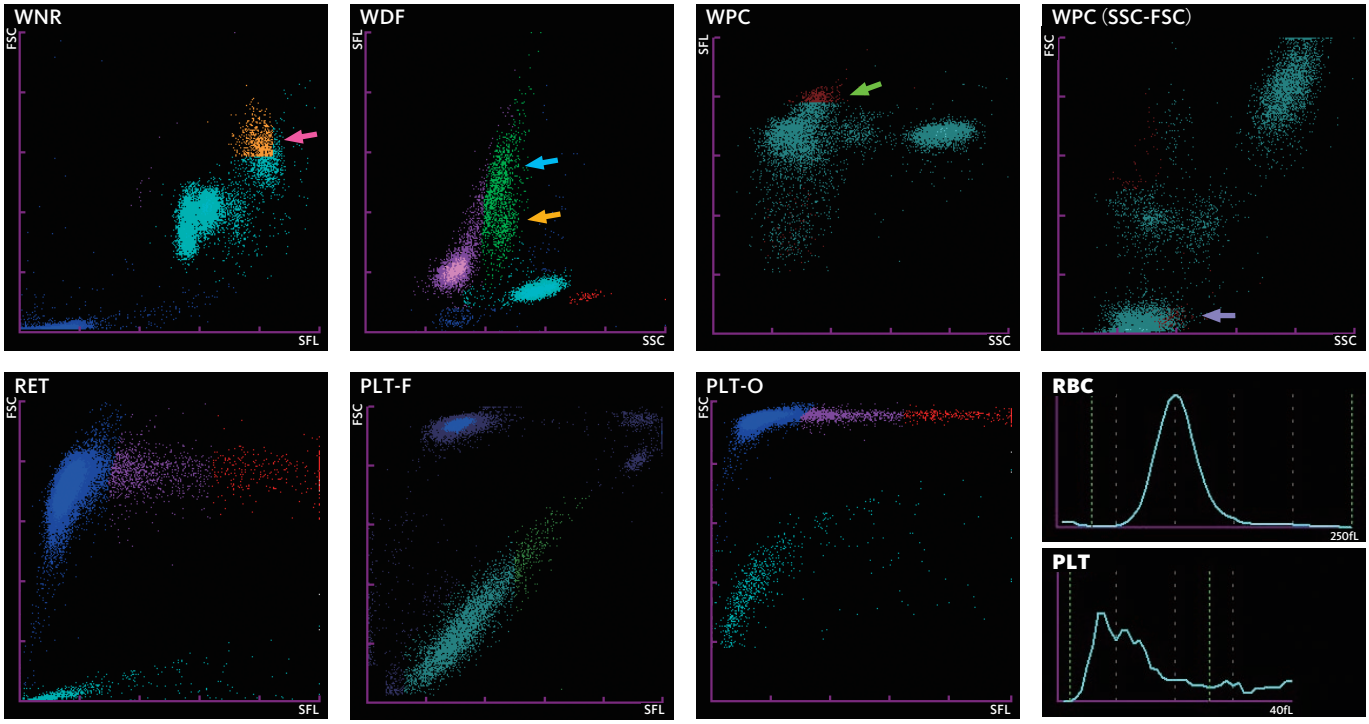
WBC	8.62	10^9/L		NEUT	2.92	10^9/L	*	33.9 % *
RBC	2.7	10^{12}/L		LYMPH	3.64	10^9/L	*	42.2 % *
HGB	92	g/L		MONO	1.24	10^9/L	*	14.4 % *
HCT	0.272	L/L		EO	0.06	10^9/L		0.7 %
MCV	100.7	fL		BASO	0.76	10^9/L	+	8.8 % +
MCH	34.1	pg		IG	0.07	10^9/L		0.8 %
MCHC	338	g/L		RET	58.9	10^9/L		2.18 %
PLT	42	10^9/L		IRF	24.0	%		
RDW-SD	57.2	fL	+	LFR	76.0	%		
RDW-CV	15.9	%		MFR	14.2	%		
PDW	18.5	fL		HFR	9.8	%		
MPV	12.3	fL		RET-He	37.8	pg		
P-LCR	45.5	%	+	IPF	3.0	10^9/L		7.0 %
PCT	0.0005	L/L	–					
NRBC	0.01	10^9/L	0.1/100 WBC					

Flags

WBC Flag(s)
Monocytosis
Basophilia
Blasts?

RBC Flag(s)
Anemia

PLT Flag(s)
Thrombocytopenia



Note

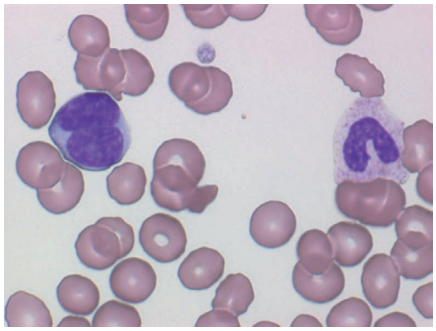
The basophil count differs from the visual count, and it is possible that the ATL-like cells seen in the smear are interfering with the cluster in the BASO area on the WNR scattergram (↑). A bimodal MONO cluster is seen on WDF scattergram (↑, ↑). Based on comparison with the visual counts, the ↑ cluster seems to correspond to ATL-like cells. These cells seem to appear at the upper part of the lymphocyte cluster on the WPC scattergram (↑). They are also detected as abnormal cells in the WPC(SSC-FSC) scattergram (↑).

Case history

An HTLV-1 antibody positive case with an enlarged left cervical lymph node, which was diagnosed as ATLL based on a lymph node biopsy. Abnormal lymphocytes were seen in peripheral blood during follow-up as outpatient.

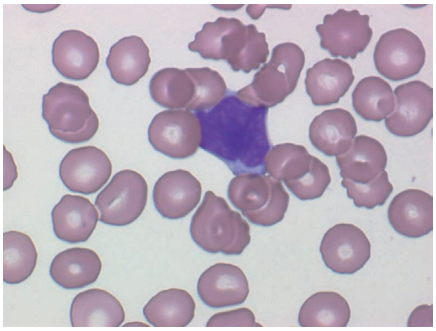
Blood smear (May-Giemsa staining)

PB



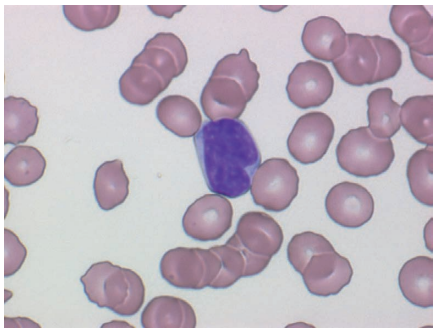
×600

PB



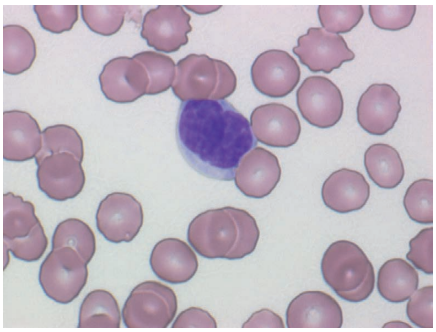
×600

PB



×600

PB



×600

Note

Peripheral blood shows anemia and thrombocytopenia, and has 10% abnormal lymphocytes. The abnormal lymphocytes are small to medium in size with basophilic cytoplasm. The nuclei are markedly pleomorphic in shape with convoluted nuclear margins giving a polylobated appearance. Bilobed nuclei are also seen. Nuclear chromatin is coarse with a tendency to be intensely stained.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.5
Meta	0.5
Stab	1.5
Segmented N.	53.5
Lymphocytes	29.0
Monocytes	4.0
Basophils	1.0
Eosinophils	0.0
Atypical Lymph	0.0
Other*	10.0
NRBC	0.0/100 WBC

*ATL-like cells

Other tests

LD (U/L)
776(110-219)

sIL-2R (U/mL)
15600(145-519)

unit : %

Cell surface antigen expressions (PB)

T-Cell		**Myeloid**	
CD2	68.5	CD14	2.9
CD3	65.2		
CD4	52.0	**Other**	
CD5	14.0	CD25	46.0
CD7	27.2	CD34	0.4
CD8	14.1	HLA-DR	52.4
B-Cell			
CD19	25.0		
NK-Cell			
CD16	5.2		
CD56	7.3		

unit : %

Note

The peripheral blood cells are positive for the T-cell markers CD2, CD3 and CD4, and have a reduced expression of CD7. They are also positive for CD25.
Based on the above, leukemic transformation of ATLL is suspected.

Infectious mononucleosis (IM)

Information from XN-Series

WBC	13.95	10^9/L		NEUT	2.27	10^9/L	*
RBC	5.36	10^{12}/L		LYMPH	10.34	10^9/L	*
HGB	159	g/L		MONO	1.08	10^9/L	*
HCT	0.489	L/L		EO	0.02	10^9/L	
MCV	91.2	fL		BASO	0.24	10^9/L	+
MCH	29.7	pg		IG	0.03	10^9/L	
MCHC	325	g/L		RET	76.6	10^9/L	
PLT	200	10^9/L		IRF	16.7	%	
RDW-SD	42.0	fL		LFR	83.3	%	
RDW-CV	12.8	%		MFR	12.4	%	
PDW	11.1	fL		HFR	4.3	%	
MPV	9.6	fL		RET-He	31.5	pg	
P-LCR	21.9	%		IPF	2.6	10^9/L	
PCT	0.0019	L/L					
NRBC	0.0	10^9/L	0.0/100 WBC				

NEUT	16.4	%	*
LYMPH	74.1	%	*
MONO	7.7	%	*
EO	0.1	%	
BASO	1.7	%	+
IG	0.2	%	
RET	1.43	%	
IRF			
LFR			
MFR			
HFR			
RET-He			
IPF	1.3	%	

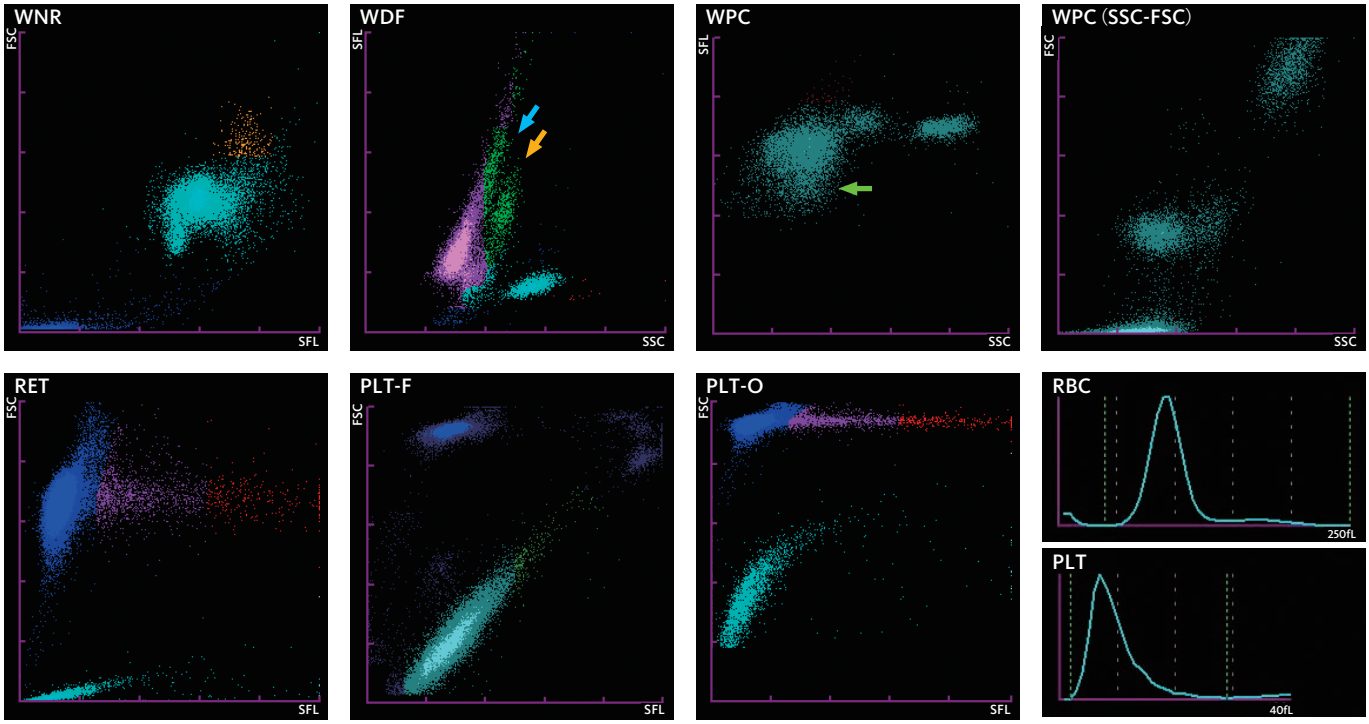
Flags

WBC Flag(s)

Lymphocytosis
Monocytosis
Basophilia
Atypical Lympho?

RBC Flag(s)

PLT Flag(s)



Note

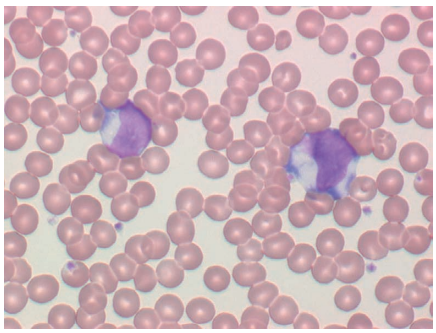
A population of signals appears as an extension of the LYMPHO cluster (indicated in pink) in the direction of higher fluorescence intensity on the WDF scattergram. Many of the atypical lymphocytes seen in smears seem to correspond to the ⬆ cluster and monocytes to the ⬆ cluster, based on comparison with visual counts. The cluster corresponding to lymphocytes spreads downwards on the WPC scattergram (⬆). Some cells are detected as abnormal cells, and plotted in the upper area of the cluster corresponding to lymphocytes (indicated in red). As a result, the “Atypical Lympho?” flag is displayed based on a comprehensive analysis of the size, center of mass, and shape of the LYMPH and MONO clusters on the WDF scattergram.

Case history

Fever of 39ºC or higher and enlargement of the cervical lymph nodes were observed 2 to 3 days prior to this presentation.

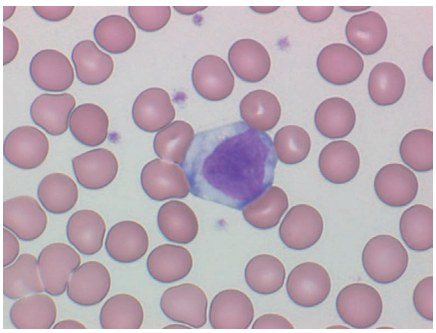
Blood smear (May-Giemsa staining)

PB



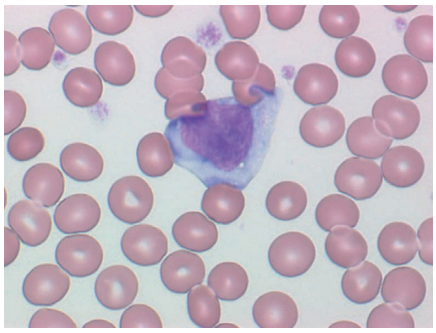
×400

PB



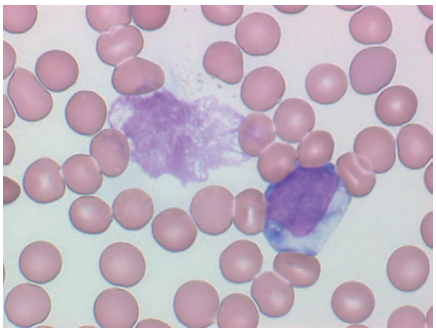
×600

PB



×600

PB



×600

Note

Peripheral blood shows a slight increase in white blood cells, and has 30% atypical lymphocytes. The atypical lymphocytes are medium to large in size with a low N/C ratio. The cytoplasm is basophilic and there is variation in the blue color intensity. Nuclear chromatin is coarse and nuclei are round to irregular in shape. Disintegrated cells and bare nuclei are also seen in the smears.

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.5
Meta	0.0
Stab	0.0
Segmented N.	26.0
Lymphocytes	37.5
Monocytes	5.0
Basophils	0.5
Eosinophils	0.5
Atypical Lymph	30.0
NRBC	0.0/100 WBC

Other tests

LD(U/L)
603(110-219)

unit : %

EBV specific antibody test

Anti-EB VCA-IgG	160
Anti-EB VCA-IgM	160
Anti-EB VCA-IgA	<10
Anti-EB EBVA	<10

unit : -fold dilution

Note

Since EBV specific antibodies show VCA-IgG positive, VCA–IgM positive and EBNA-negative, infectious mononucleosis due to an early stage of EBV infection is suspected.

XN-Series

Other abnormalities

Megaloblastic anemia

Information from XN-Series

WBC	2.74	10^9/L	–
RBC	1.23	10^{12}/L	–
HGB	50	g/L	–
HCT	0.148	L/L	–
MCV	120.3	fL	+
MCH	40.7	pg	+
MCHC	338	g/L	
PLT	59	10^9/L	
RDW-SD	79.3	fL	+
RDW-CV	21.8	%	+
PDW	----	fL	
MPV	----	fL	
P-LCR	----	%	
PCT	----	L/L	
NRBC	0.02	10^9/L	0.7/100 WBC

NEUT	1.57	10^9/L	57.2 %
LYMPH	1.06	10^9/L	38.7 %
MONO	0.07	10^9/L	2.6 %
EO	0.04	10^9/L	1.5 %
BASO	0.00	10^9/L	0.0 %
IG	0.01	10^9/L	0.4 %
RET	12.3	10^9/L	1.00 %
IRF	17.9	%	
LFR	82.1	%	
MFR	14.0	%	
HFR	3.9	%	
RET-He	40.9	pg	
IPF	3.0	10^9/L	8.1 %

Flags

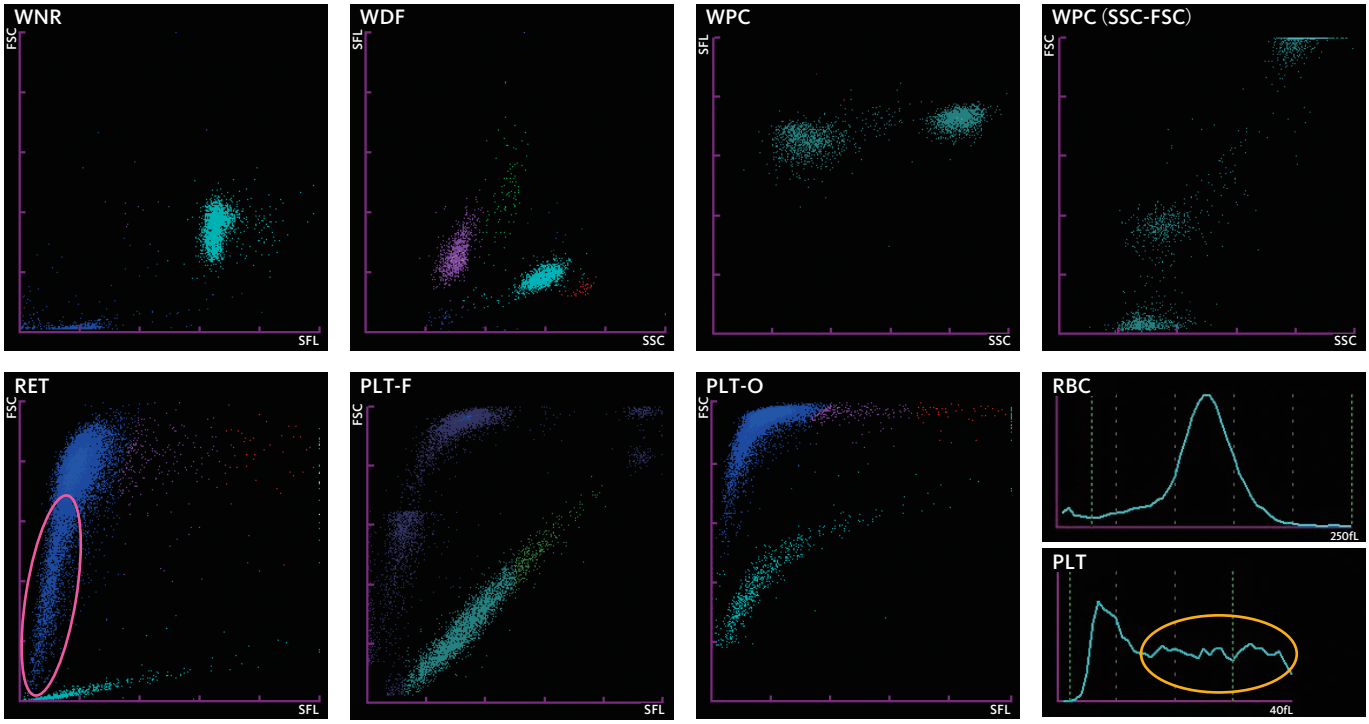
WBC Flag(s)

RBC Flag(s)

- Anisocytosis
- Macrocytosis
- Anemia
- Fragments?

PLT Flag(s)

- PLT Abn Distribution
- Thrombocytopenia



Note

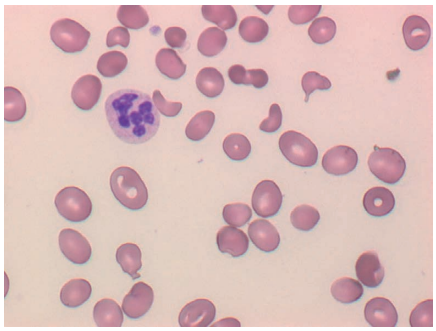
The white blood cell count is slightly decreased and red blood cell and platelet counts are considerably decreased. MCV and RDW-SD are high and the RBC histogram indicates anisocytosis, and the “Anisocytosis” and “Macrocytosis” flags are displayed. Some of the poikilocytes seen in the smear are small and deeply stained, and it is assumed that they are the reason for the high MCH. On the RET scattergram, the mature red blood cell cluster extends toward the platelet area (○), suggesting the presence of microcytic red blood cells. There seems to be interference by poikilocytes on the PLT histogram, and platelet-related analysis parameters are consequently not measurable (○). However, the PLT-F scattergram which specifically detects platelets shows a normal pattern.

Case history

The patient felt general malaise, which gradually worsened. A checkup in a nearby clinic detected pancytopenia and the patient was referred to our hospital.

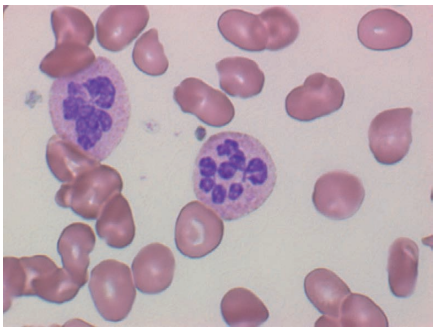
Blood smear (May-Giemsa staining)

PB



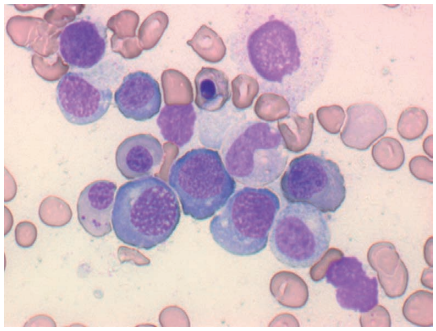
×400

PB



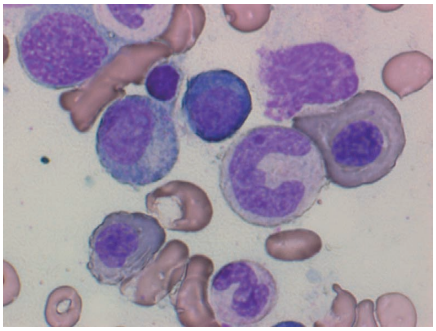
×600

BM



×400

BM



×600

Note

Peripheral blood shows pancytopenia. The red blood cells have considerable anisocytosis, with macrocytes and poikilocytes. Hypersegmentation is also observed in some neutrophils.
Bone marrow shows normoplasia and an increase in erythroblasts. Erythroblasts are large in size and megaloblastoid changes are seen. No blasts are present, and giant metamyelocytes and giant stab neutrophils are seen. Since the serum vitamin B_{12} level is low, this is considered to be a case of megaloblastic anemia (pernicious anemia).

Visual differential counts

PB	
Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	0.0
Segmented N.	70.0
Lymphocytes	24.0
Monocytes	2.0
Basophils	0.0
Eosinophils	4.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

Other tests

LD (U/L)
942(110-219)

Vitamin B_{12} (pg/mL)
83(233-914)

Folic acid (ng/mL)
13.1(3.6-12.9)

BM			
NCC (×10⁴/μL)	12.3	Pro Erythroblast	1.0
Megakaryo (/μL)	30.0	Baso Erythroblast	4.7
Myeloblast	0.2	Poly Erythroblast	27.6
Promyelo	0.7	Orth Erythroblast	9.6
Myelo	10.2	M:E ratio	1.1
Meta	5.5		
Stab	8.0		
Segmented N.	22.3		
Eosinophils	2.0		
Basophils	0.2		
Lymphocytes	6.0		
Monocytes	0.2		
Plasma	1.2		
Macrophage	0.4		
Megakaryo	0.2		

unit : %

Idiopathic/immune thrombocytopenic purpura (ITP)

Information from XN-Series

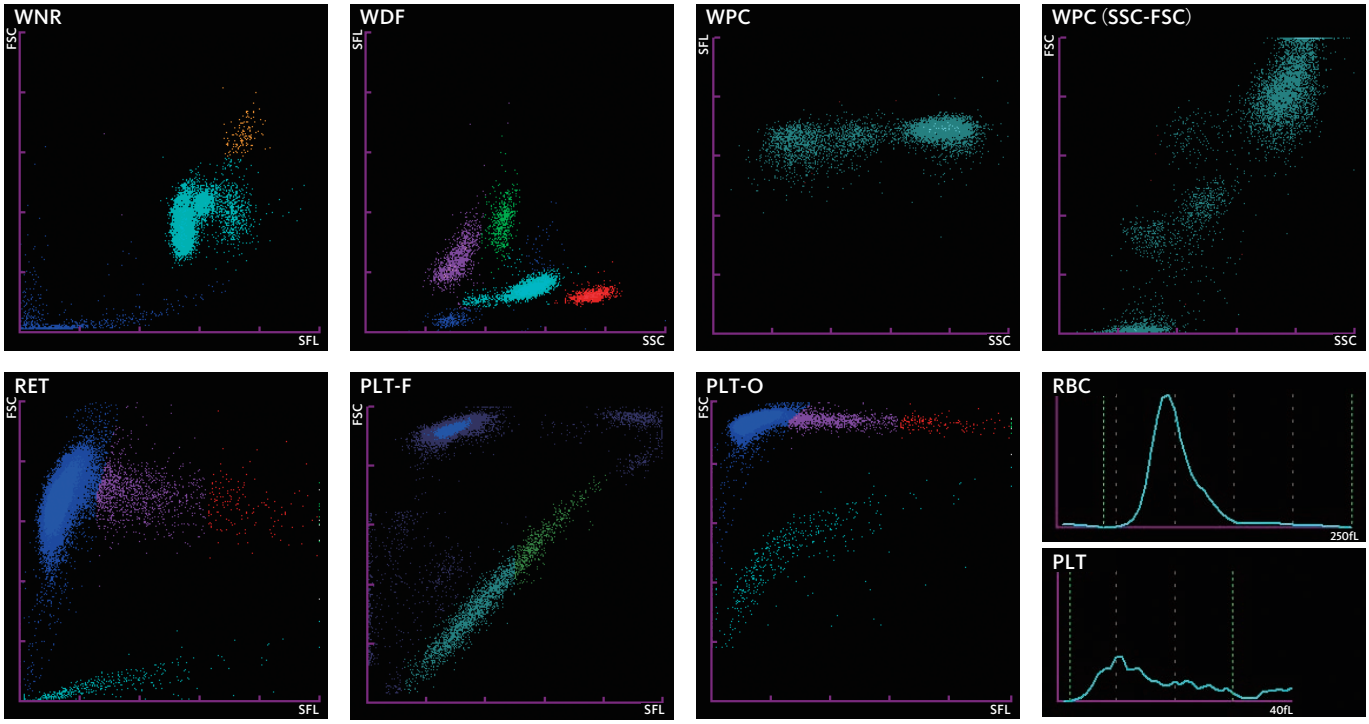
WBC	7.26	10^9/L		NEUT	4.11	10^9/L	56.6 %
RBC	3.51	10^{12}/L		LYMPH	1.48	10^9/L	20.4 %
HGB	110	g/L		MONO	0.46	10^9/L	6.3 %
HCT	0.342	L/L		EO	1.05	10^9/L +	14.5 % +
MCV	97.4	fL		BASO	0.16	10^9/L +	2.2 % +
MCH	31.3	pg		IG	0.06	10^9/L	0.8 %
MCHC	322	g/L		RET	65.6	10^9/L	1.87 %
PLT	27	10^9/L *		IRF	10.9	%	
RDW-SD	56.0	fL +		LFR	89.1	%	
RDW-CV	15.9	%		MFR	9.7	%	
PDW	----	fL		HFR	1.2	%	
MPV	----	fL		RET-He	31.6	pg	
P-LCR	----	%		IPF	5.7	10^9/L	22.6 %
PCT	----	L/L					
NRBC	0.01	10^9/L	0.1/100 WBC				

Flags

WBC Flag(s)
Eosinophilia

RBC Flag(s)

PLT Flag(s)
PLT Abn Distribution
Thrombocytopenia



Note

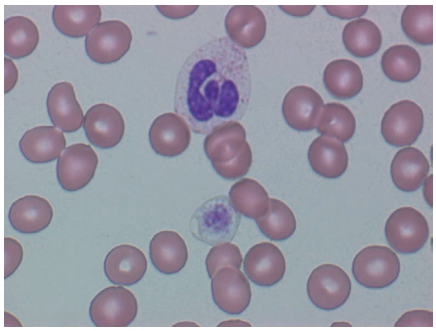
The platelet count is low. The giant platelets seen in the smears are plotted (indicated in green) in the IPF area of the PLT-F scattergram. The IPF is also high at 22.6%. The WDF, WNR and WPC scattergrams show normal patterns and the differential white blood cell count matches the visual counts.

Case history

The patient has been hospitalized for treatment of meningitis. As peripheral blood showed thrombocytopenia, extensive tests were carried out.

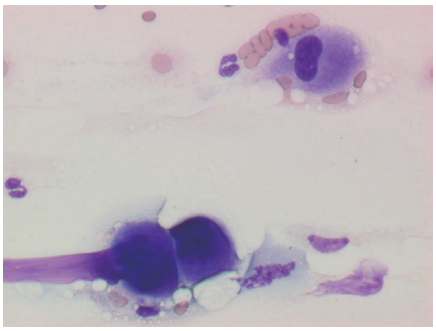
Blood smear (May-Giemsa staining)

PB



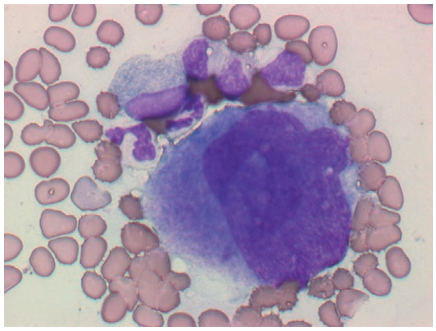
×600

BM (tail end of the smear)



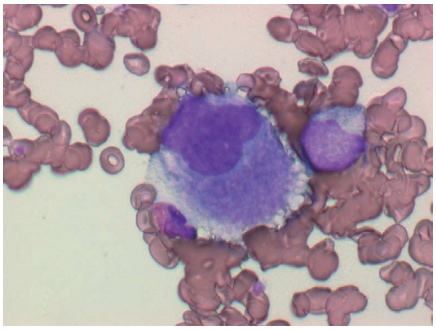
×200

BM



×400

BM



×400

Note

Peripheral blood shows anemia and thrombocytopenia, and giant platelets are seen in the smear. White blood cells and red blood cells have no morphological abnormalities.
Bone marrow shows normoplasia without increase in blasts. An increase in megakaryocytes is observed in the smears. The cytoplasm of megakaryocytes is stained deep blue in color. Some of them are mononuclear. No attachment of platelet clusters are noted.
A blood test shows elevated HPA-IgG.
Based on the above, this is considered to be a case of immune thrombocytopenic purpura (ITP).

Visual differential counts

PB

Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	0.0
Segmented N.	58.0
Lymphocytes	21.0
Monocytes	6.0
Basophils	1.0
Eosinophils	14.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

Other tests

LD (U/L)
207(110-219)

HPA-IgG (ng/10^7cells)
322(46 and lower)

BM

NCC (×10^4/μL)	5.9
Megakaryo (/μL)	90.0
Myeloblast	0.5
Promyelo	0.9
Myelo	5.4
Meta	4.7
Stab	6.8
Segmented N.	29.4
Eosinophils	9.5
Basophils	0.6
Lymphocytes	12.7
Monocytes	5.3
Plasma	0.2
Macrophage	1.0
Megakaryo	0.3

Pro Erythroblast	0.1
Baso Erythroblast	0.8
Poly Erythroblast	21.8
Orth Erythroblast	0.0
M:E ratio	2.5

unit : %

May-Hegglin anomaly (MH)

Information from XN-Series

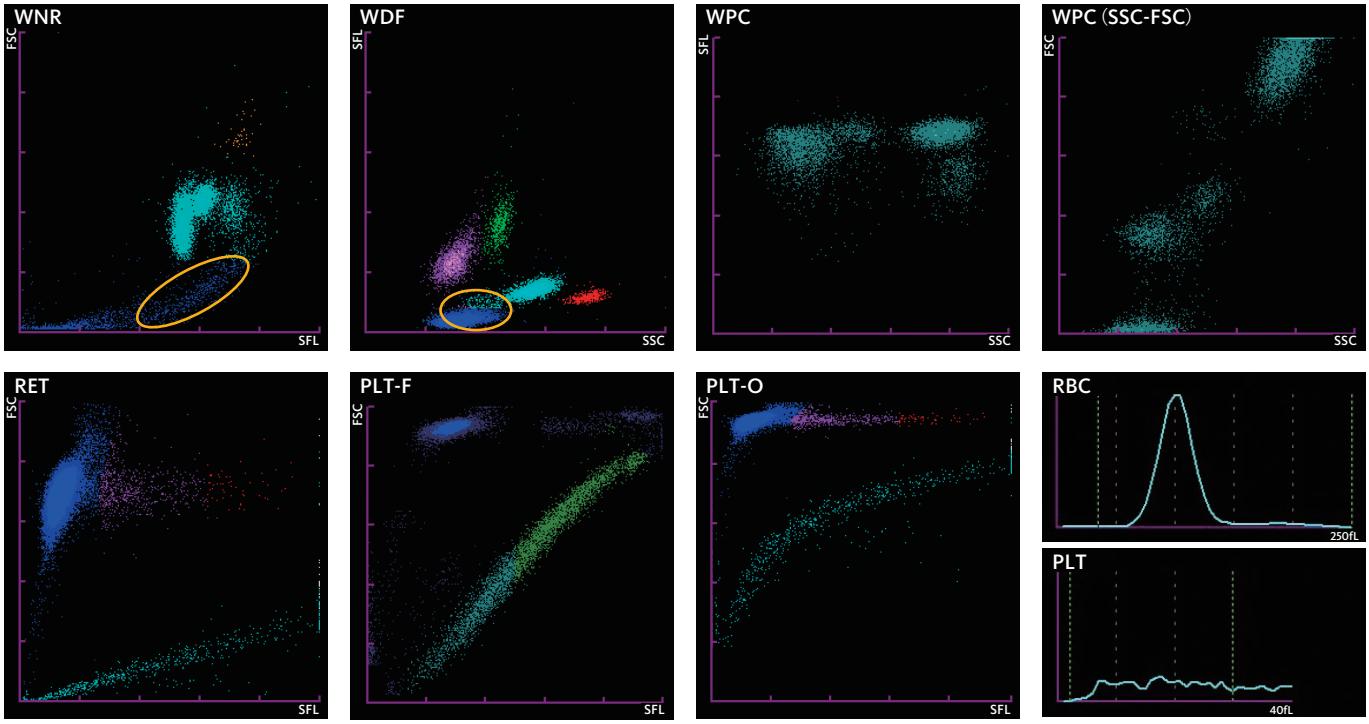
WBC	7.24	10^9/L		NEUT	3.62	10^9/L	50.0 %
RBC	4.2	10^{12}/L		LYMPH	2.59	10^9/L	35.8 %
HGB	132	g/L		MONO	0.45	10^9/L	6.2 %
HCT	0.418	L/L		EO	0.53	10^9/L +	7.3 % +
MCV	99.5	fL		BASO	0.05	10^9/L	0.7 %
MCH	31.4	pg		IG	0.01	10^9/L	0.1 %
MCHC	316	g/L		RET	31.9	10^9/L	0.76 %
PLT	22	10^9/L *		IRF	8.5	%	
RDW-SD	47.3	fL		LFR	91.5	%	
RDW-CV	12.9	%		MFR	7.9	%	
PDW	----	fL		HFR	0.6	%	
MPV	----	fL		RET-He	33.0	pg	
P-LCR	----	%		IPF	26.8	10^9/L	63.7 %
PCT	----	L/L					
NRBC	0.0	10^9/L	0.0/100 WBC				

Flags

WBC Flag(s)

RBC Flag(s)

PLT Flag(s)
PLT Abn Distribution
Thrombocytopenia



Note

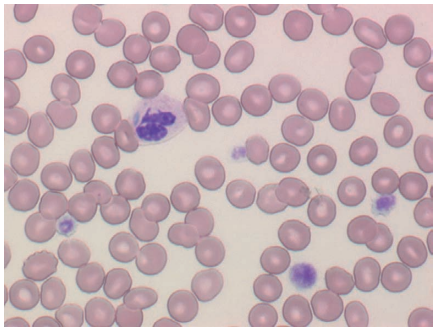
Abnormal "Ghost" populations (○) caused by the appearance of large and giant platelets are seen on the WNR and WDF scattergrams. The PLT histogram shows an abnormal pattern, and the PLT-I count measured with the impedance method cannot detect the giant platelets correctly. However, the PLT-F scattergram, which detects platelets specifically, shows a clear PLT cluster. Many cells are plotted in the IPF area (indicated in green), and IPF is very high at 63.7%. These are the large to giant platelets seen in the smears, and the value matched the visual count.

Case history

A case of an outpatient being followed up for thrombocytopenia.

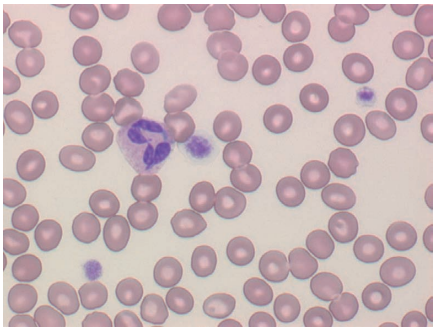
Blood smear (May-Giemsa staining)

PB



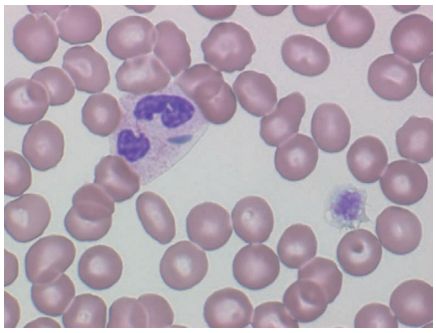
×400

PB



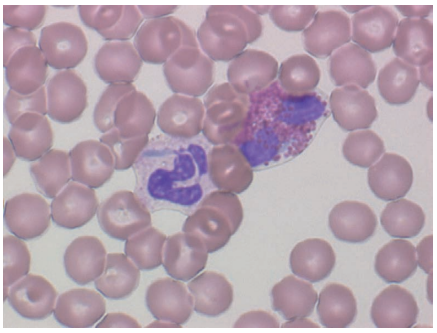
×400

PB



×600

PB



×600

Note

The platelet count is low. Many platelets are large in size and some are giant platelets as large as red blood cells. Dohle-like inclusion bodies are seen in the cytoplasm of granulocytic cells. The inclusion bodies are spindle-shaped and blue, and their boundary with the cytoplasm is distinct.
Based on the above, May-Hegglin anomaly is diagnosed.

Visual differential counts

PB	
Myeloblast	0.0
Promyelo	0.0
Myelo	0.0
Meta	0.0
Stab	0.0
Segmented N.	62.0
Lymphocytes	24.0
Monocytes	5.0
Basophils	1.0
Eosinophils	8.0
Atypical Lymph	0.0
NRBC	0.0/100 WBC

unit : %

XN-Series