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Short communication

DETERMINATION OF WHITE BLOOD CELLS USING FOLDSCOPE WITH SMARTPHONE

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Introduction

The Microscope is used in clinical laboratory for determination & morphology analysis of white blood cells of human blood smear but due to its high cost, heavy weight & portability issue, it is not available in everywhere such as rural area, flooded area. Handling & using of microscope also required well trained &skilled microscopist. Here we implemented a novel origamibased cheap and portable microscope "Foldscope" [1] for determination of white blood cells of human blood smear. This foldscope is origami based printed and fold paper microscope, which can magnify up to 2000 X, would be sufficient to identify harmful microorganisms like E. coli and Giardia[2]. The counting and analysis of blood cells allows the evaluation and diagnosis of a vast number of diseases. The generic term leukocytes refer to a set of cells quite different each other. The leukocyte

Abstract

We are traditionally used Microscope in clinical laboratory for determination of white blood cells of human blood smear. Now, in this study we were used Foldscopewith Smartphone in the place of Microscope and examine many samples of human blood smear which was collected from local diagnostic centers. We were very easily quantity & morphology analysis of all types of WBC cells such as Neutrophils, Lymphocytes, Monocytes, Eosionophils, Basophils in blood smear with the help of Foldscope& image taken by Smartphone. The main objective of this study is to use Foldscopefor quantity & morphology analysis of human WBCs at field level especially poor resource area where healthcare services or centers is not available & where carry of microscope is not possible.

Keywords: Foldscope; White blood cells; Diagnostic; Healthcare.

cells containing granules are called include granulocytes and neutrophils, basophils and eosinophils. The cells without granules are called agranulocytes and include the lymphocytes and monocytes. Thus we can distinguish between them, not only according to the shape or size, but also thanks to the presence of granules in the cytoplasm and also by the number of lobes in the nucleus. The lobes are the most substantial part of the nucleus and are connected to each other by thin filaments. Neutrophils are mainly present in human blood with a percentage ranging between 50 and 70%, have sizes around 10-12 microns and are distinguishable due to the number of lobes present in the nucleus, which can be up to a maximum of 5. Basophils instead represent only 0-1% of lymphocytes in human blood, have a diameter of about 10 microns and, generally, a nucleus with two lobes. Eosinophils are present for the 1-5% in

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human blood, have predominantly rounded shape with dimensions around 10-12 microns, and have a nucleus with more lobes, but not greater than 2. They differ from other white blood cells for the presence of granules, which include paracrystalline structures in the form of "coffee bean". In human blood is very common the presence of lymphocytes, with a percentage of 20-45% and a size of 7-15 microns, characterized by a rounded nucleus and a cytoplasm poor. Monocytes are the most voluminous white blood cells, with a diameter of 12-18 microns and representing 3-9% of circulating leukocytes[3].

Materials & Methods

Samples:We collected total 25Leishman stained human blood film smear slides were used as sample to determination of white usingFoldscope blood cells with Smartphone. These blood slides were collected from Maa Tara Pathology Mathahi, Madhepura,

MaaKoshiLaboratoyMadhepura, Yaduvansi Laboratory Madhepura& New Micro Lab Madhepura, Bihar, India.

Materials: One commercial handheld, portable optical origami types paper microscope, named "Foldscope" was used the conduct this study. This Foldscope was bought from Foldscope instruments, Inc.

CA). Mobile-phone (San Francisco, (Samsung Galaxy A6+, Samsung, Korea) was coupled with the Foldscope by using tape and magnetic coupler for taking image of the blood samples. The Foldscope was manually panned and focused according to the guideline of the manufacturer.LED magnifier was used as a light source.

Methodology: Raw Foldscope paper was open and assembled in order to conduct this study. After assembly, stained blood film slides were being imaged through Foldscope and mobile phone.

Image Processing: All images were saved in IPEG format.

Results

The study was conducted total 25Leishman stained human blood film slides were collected from local diagnostic centers of Madhepura, Bihar, India. All human blood film slides were adjusted on Foldscope one by one and images ware taken with adjusted Smartphone. During image taking LED magnifier was used as a light source. The Smartphone captured images of the blood smear are illustrated in figure 1 to 4. We apply the zoom option of the Smartphone camera 8X in image taken. Morphologically WBCs cells were found very clearly in figure 1 to 4 respectively.



Figure 1.



Figure 2.

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Figure 3.

Figure 4.

Figure 1, 2, 3, & 4 – Foldscope captured image of Human blood cells (8X zoom in phone camera)

We also count percentage of WBCsof all 25 blood film slides one by one using Foldscope with Smartphone by moving blood film slide from one field to the next systematically 100 cells of each slides & recorded the types of WBCs seen in each field. We ware found following results –

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PERFORMANCE OF QUANTITATIVE TEST	

Slide No.	Neutrophils	Lymphocytes	Monocytes	Eosionophils	Basophils	Total
1.	56	38	1	5	0	100
2.	60	32	1	7	0	100
3.	<mark>73</mark>	21	2	4	0	100
4.	55	40	0	5	0	100
5.	58	38	1	3	0	100
6.	53	42	1	4	0	100
7.	65	30	1	4	0	100
8.	59	30	1	10	0	100
9.	67	24	1	8	0	100
10.	40	<mark>51</mark>	2	7	0	100
11.	60	34	2	4	0	100
12.	72	22	2	4	0	100
13.	61	28	1	10	0	100
14.	57	40	0	3	0	100

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15.	50	45	1	4	0	100
16.	66	30	0	4	0	100
17.	<mark>74</mark>	22	1	3	0	100
18.	62	31	0	7	0	100
19.	58	36	2	4	0	100
20.	<mark>74</mark>	20	1	5	0	100
21.	57	33	1	<mark>9</mark>	0	100
22.	<mark>72</mark>	19	2	7	0	100
23.	56	36	1	7	0	100
24.	63	32	0	5	0	100
25.	59	35	1	5	0	100

In quantitative test results were slide no. 3, 17, 20 & 22 abnormalities of show Neutrophils, Slide 10 no. show abnormalities of Lymphocytes, & slide no. 2, 8, 9, 10,18, 20,21, 22, 23 show abnormalities of Eosinophils.

Conclusion

In this work "Foldscope" is easy to use for determination of WBCs of human blood & they give good results. Method we applied & describe here is novel, cheap, quite convenient & suitable for human blood hematology especially morphological analysis &quantity investigation like cell counting. This method is very useful to Pathological laboratory specially were lack of resources. The image of WBCs cells of human blood is viewing very clear & identical. This novel paper microscope "Foldscope" could lead a better healthcare improvement in poor resource area where healthcare services or centers is not available & where carry of microscope is not possible.

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Conflict of interest

Authors declares no conflict of interest

Compliance with Ethical Standards

The authors declare that they have no conflict of interest. This article does not contain any studies involving animals or human participants performed by any of the authors

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