



Mobile Camera Microphotography: A Simple But Elegant Technique For Telediagnosis of Malaria

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Malaria is still widely prevalent in developing countries, leading to sizable morbidity and mortality. Early and accurate diagnosis of the nature of malarial parasite is made with microscopy or rapid diagnostic strip tests. This is essential and crucial for appropriate choice of antimalarial drugs. Patients are deprived of rational management and are at a high risk with either false negative or false positive diagnosis of malaria (1). As a consequence significant research has been carried out to develop sophisticated methods of precision and accuracy e.g. fluorescence of the parasite DNA, PCR, monoclonal antibody tests involving DNA, proteins and parasite specific enzyme (2, 3). However, microscopic diagnosis of *Plasmodium falciparum* or *Plasmodium vivax* by a careful examination of a well-stained blood smear still remains the gold standard. The simplicity, cost effectiveness and sensitivity (5-10 parasites/ μ l) of the microscopic technique makes it a globally accepted method (4). However, the expertise and meticulousness needed for such microscopic diagnosis is not widely available, particularly in remote and rural areas. Telediagnosis of malaria from such places is a challenge to the medical world.

Reports of use of Mobile for teledermatology (5), and Java-enabled 3G mobile phone for monitoring the vital biosignals of patients in ICU/CCU, such as ECG, RESP, SpO₂, EtCO₂ are available (6). However, recently, 'The Economist' (17th May 2008) published a news item entitled, "Doctors on call.". The team at the University of California, Berkely, led by Dan Fletcher, is developing

a mobile telephone (cell phone) with an in-built microscope, and a notch to place the slide of blood smear of a patient with a suspected diagnosis of malaria. The device will be a sophisticated mobile microscope with an advanced digital camera to capture microphotographs



Fig.1: Mobile phone microphotography: RBCs from normal blood smear

(Normal blood smear under oil emersion: Zeiss Axiostar Plus Microscope, Photograph by Nokia N76 mobile camera (2 mega pixel)

of the blood smear. The digitized image can then be sent via internet to an expert for an accurate diagnosis of malaria. This approach opened up our vision for tele diagnosis of malaria in rural India, which has now a sizeable network for mobile phones.

The whole of idea to simplify this concept occurred to one of the authors (ABV) of using the very camera of the common mobile phone directly over the eyepiece of the microscope. This would generate digitized image of the erythrocytes in the blood smear, with or without the parasites. To check the feasibility, initially a normal

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Fig.2: *P. falciparum* rings (Black Arrows), Microscopy: Zeiss Axiostar Plus, Photograph: 2 mega Pixel camera Nokia N76 mobile

blood smear stained with Field's Stain was observed under oil immersion lens (100X), using Zeiss Axiostar Plus microscope. A photograph was taken with a 2 megapixel camera of Nokia N 76 mobile phone. The image of RBCs, with this technique is shown in (Fig.1)

The aforesaid technique was refined, by adjusting the magnification, light intensity and steadying the camera on the eyepiece etc. This led to a better and sharper image of RBCs with malarial parasites in the blood smear. The images of the parasitized RBCs were transferred to computer via blue tooth and then e-mailed via internet to our collaborators in malaria research, including Drexel University College of Medicine (Prof. Akhil Vaidya, Director, Centre of Molecular Parasitology), Philadelphia. The ring forms of *Plasmodium falciparum* in RBCs are shown in (Fig.2); whereas, (Fig.3) shows the same image edited for brightness, background and colour, using photoshop software. The technique of mobile camera microphotography (MCM) is being further fine-tuned technologically by several steps to enhance the quality of the digitized image. Once a quality image is digitized, there are several options for expert opinions for a quick feedback on the diagnosis. Considering the penetration of the mobile network in India, MCM can be applied, for telediagnosis,

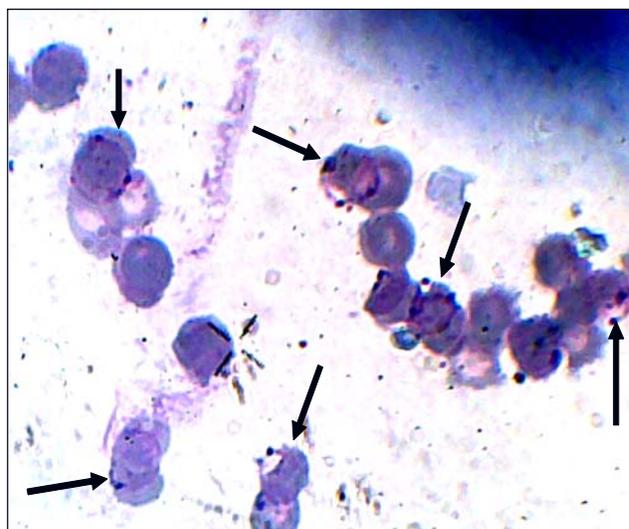


Fig. 3: Mobile Phone Microphotography: Modified photograph 2

in India as well as globally. Several life-threatening diagnostic challenges can be averted by timely expert feedback on ECG, blood smears, clinical photography of lesions etc. We need to develop MCM as a major tool in health care.

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