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ORIGINAL ARTICLE

Investigation on *Plasmodium falciparum* and *Plasmodium vivax* infection influencing host haematological factors in tribal dominant and malaria endemic population of Jharkhand

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Abstract The study was undertaken to elucidate the association of host haematological and biochemical indices in *Plasmodium falciparum* and *Plasmodium vivax* malaria in order to explore whether these parameters are unique to disease or act as a potential diagnostic marker.

Haematological and biochemical parameters in 106 malarial patients and 33 healthy subjects were evaluated.

Following parameters were significantly lower in all infection types (*P. vivax*, *P. falciparum* and mixed infection); haemoglobin, blood sugar, PCV and blood urea, while ESR is significantly higher in all types of infection whereas serum bilirubin and creatinine are significantly higher except mixed and vivax infection, respectively. Interestingly, parasitaemia, temperature and age are significantly correlated with blood urea, blood sugar and ESR respectively in vivax infection whereas parasitaemia with PCV and blood sugar and age with PCV in *falciparum* infection.

Malaria infected subjects exhibited alterations in some haematological parameters with low haemoglobin, blood sugar and PCV whereas elevated ESR and serum bilirubin being the important findings observed in our study. These evaluations could be considered to be reliable clinical and

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biochemical markers for promising diagnostic potential during clinical malarial infection in combination with other genetic and classical microscopic parameters. Haematological evaluation could help in prompt and accurate diagnosis and prevent disease progression by facilitating physicians in clinical correlation for better drug regime.

1. Introduction

Malaria is a major cause of morbidity in the tropics, thus disease is of global importance that results in 300–500 million cases and 1.5–2.7 million deaths yearly (Snow et al., 2005). Approximately 2.48 million malarial cases are reported annually from South Asia, of which 75% cases are contributed by India alone (Yadav et al., 2011). In malaria infected patients, especially non immune children and adults prompt an accurate diagnosis, which is seminal to effective disease management and to prevent fatal outcome. Clinical diagnosis, fever, febrile illness and other signs and symptoms are known to be reasonably sensitive measures of malaria, but they lack specificity and positive predictive values especially in areas where malaria is less prevalent (Erhart et al., 2004). Moreover, in tropical countries like India where malaria is most prevalent, it may be difficult to distinguish the malaria from other infection e.g. viral or bacterial based on the symptoms and signs (Lathia and Joshi, 2004). Preventive antimalarial treatment is widely practiced and studies showed that significant misuse of antimalarial drugs is among the major causes of drug resistance (Barnish et al., 2004). Further, microscopic diagnosis, although is the gold standard for malarial parasite detection and speciation requires technical expertise, repeated smear examination and is time consuming. However, it is a valuable technique and performed correctly with adequate expertise hands but can be unreliable and perceived as wasteful when poorly executed.

Infections of red blood cells result in various changes in haematological parameters and are likely to be influenced by any disease condition which affects the haemopoietic physiology at any level. This is likely to happen with an endemic disease such as malaria that affects the host homeostasis at various fronts resulting in a myriad of clinical presentation. Undoubtedly, blood is the most easily accessible diagnostic tissue and haematological and biochemical variations are some of the most common complications in malaria and they play a major role in malarial pathology.

Jharkhand is situated in the eastern region of India, and bordered by states of Bihar, Madhya Pradesh, Orissa and West Bengal. It spans an area of 79,700 square km and the population of the state is 30,010,000, out of which 32% is tribal while 14% of the people belong to schedule caste. 80% of the inhabitants reside in rural areas as the main crop of state is rice and 82% of the population are involved in agriculture for their livelihood. There are well defined seasons in Jharkhand, winter (November–February), summer (March–mid June), and rainy season (mid June–October), which brings nearly all of the state's annual rainfall ranging from 40 inches (1000 mm) in the west central part of the state to more than 60 inches (1500 mm) in the south west. Rainfall on the plateau is generally heavier than on the plains. The complexity and magnitude of malaria in the central eastern part of India deserve special mention and attention as the central eastern state contributes 15–20% of total malarial cases in the country (Draft on National Policy on Tribals by Govt. of India; 2005). Jharkhand had a yearly average slide positivity rate (SPR) for symptomatic individuals of 10.4% over the last three years with *Plasmodium falciparum* accounting for 44% of the cases (State Malaria Control Program, 2008). Jharkhand, an understudied and tribal dominant region with perennial malarial transmission zone where malaria is rampant causing 20×10^3 annual malarial deaths, second to Orissa in India as per the latest observation published by Dhingra et al. (2010) in Lancet, reflects the importance of the area and the necessity of undertaking extensive investigation when malarial pathology is concerned. However the morbidity in Jharkhand ranges from 1.5 to 2.3 lakh cases annually over the last three years whereas mortality ranges from 16 to 35 cases annually over the last three years as per the Directorate of National Vector Born Disease Control Programme, India and the Ministry of Health and Family Welfare, Govt. of India.

Hazaribag, a semi-urban district, located at a longitude between 85°1′ E and 85°9′ E and latitude between 23°5′ N and 24°4′ N situated at a height of 2019 ft. above the sea level. Hazaribag in the state of Jharkhand (Eastern India) lying in the tropical zone with annual rainfall of 1234.5 mm has favourable geo-climatic and ecological conditions conducive for perennial malarial transmission. It is known for stable and rampant malaria with a yearly average slide positivity rate (SPR) for symptomatic individuals of 7.4% over the last few years. Some of the areas of the state viz. Palamau, Gumla and Singhbhum are high transmission areas with 18–21% SPR while Hazaribag, Bokaro and Ranchi are low transmission areas with up to 7.8% SPR. (State Malaria Control Program, 2008).

A prompt and early diagnosis is important for effective management in malaria. Many acute febrile illnesses like viral fever, arboviral infections, enteric fever and leptospirosis occur in the tropics and it is difficult to distinguish malaria from these illnesses on clinical grounds alone. Haematological changes associated with malarial infection, such as haemoglobin, packed cell volume, blood sugar, blood glucose, serum bilirubin, serum creatinine are well recognized, but specific changes may vary with the level of malaria endemicity, background haematological and nutritional status, demographic factors and malarial immunity (Price et al., 2001). However, our knowledge of haematological profile of malaria endemic population of Jharkhand and its relation to promising biochemical diagnostic potential and monitoring in malarial patients is limited. Thus, we investigated the haematological and biochemical alterations in the persons infected with *P. falciparum*, *Plasmodium vivax* and with mixed infection from tribal dominant and malaria endemic population of Hazaribag, Jharkhand and compared with healthy subjects from the same community. Furthermore, diagnostic value of these haematological and biochemical alterations has not been investigated before in the population living in malaria endemic areas. Additionally, the clinical symptoms and haematological patterns and their possible predictive values of malaria in this epidemic population are identified. Such indicators may heighten the