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Research Article

LACTATE DEHYDROGENASE (LDH) AS A BIO-CHEMICAL MARKER IN FALCIPARUM MALARIA –A CASE CONTROL STUDY IN A TERTIARY CARE CENTRE

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ABSTRACT

Aim: To establish Plasmodium Falciparum LDH isoenzyme as bio-chemical marker in falciparum malaria patients for diagnosis, severity and treatment monitoring of the disease.

Methods:

Study group comprised 170 diagnosed cases of falciparum malaria (90 uncomplicated,80 complicated) as per WHO 2000 guidelines. Age & sex matched afebrile 80 healthy individuals were randomly selected from the outpatient department comprised the control group. Diagnosis of falciparum malaria was done by Giemsa stained peripheral blood smear and LDH based rapid diagnostic test. Routine investigation of blood haemoglobin (Acid Haematin method), DC, TLC, Fasting plasma glucose (GOD-POD method),Serum sodium, potassium, Lipid profile, blood Urea, serum Creatinine, serum Bilirubin, AST, ALT, ALP were carried out in the study and control group immediately after collection of blood.

Results: The serum LDH mean value was found to be 1778.0 ± 221.01U/L in malaria (both complicated and uncomplicated)cases. The value was significantly higher than control LDH activity of 399 ± 71.2U/L ($p<0.0001$). LDH was significantly negatively correlated with blood hemoglobin and a significant positive correlation was observed with serum bilirubin, aspartate aminotransferase (AST), alanine aminotransferase (ALT), and the Creatinine levels in the study group.

Conclusion: LDH appears to hold great promise as an effective prognostic indicator and biomarker of a haemolytic mechanism of vascular pathobiology in patients with malaria as a readily available clinical laboratory test.

INTRODUCTION

Malaria is a massive global health problem and 5th leading cause of death by any infectious disease worldwide [(1)]. Currently about 106 countries are considered to be malarious and almost half of them are located in Africa. As per the World Malaria Report, 2008, in terms of malaria incidence, India ranks 15th among 109 countries and contributed around two percent of global cases in 2006. An estimated 3.3 billion people were at risk of malaria in 2010. The state of Odisha, part of peninsular India, situated along the east coast extending from $17^0 49'$ to $22^0 34'$ N and $81^0 28'$ to $87^0 29'$ E is hyper-endemic for malaria. It is a major public health problem in the state of Odisha. With 4% of India's population, the state contributes 28.6% of total malaria cases, 35% of P.*falciparum* malaria cases and 50% of total malaria deaths in the country[(2)].

Falciparum malaria is a potentially lethal infection. Out of the five species of plasmodium that infect human, Plasmodium *falciparum* is responsible for the majority of severe cases and death. The predominant causes of mortality in these patients is due to severe malaria [(3)].

Pathophysiological processes are usually associated with acute P. *falciparum* malaria infections, i.e., the hepatic activity of the invading sporozoites leading to centrilobular liver damage and the destruction of the host red blood cells consequent to erythrocytic merogony[(4)].

Lactate dehydrogenase (LDH) is an intracellular enzyme (EC 1.1.1.27) present in a wide variety of organisms including plants and animals. It is classified as a true intracellular enzyme [(5)] because of its high degree of tissue specificity where overall tissue concentrations are some 500-fold greater than serum levels under normal circumstances[(6)]. Tissue breakdown

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releases LDH, and therefore LDH can be measured as a surrogate for tissue breakdown. Generally, high concentrations of LDH are found in the liver, heart, erythrocytes, skeletal muscles and kidneys [(7)]. Consequently, diseases affecting those organs, such as renal infarction, myocardial infarction and haemolysis, have been reported to be associated with significant elevations in total serum LDH activity. Such elevations have been widely applied as diagnostic indices for kidney, liver, heart and red blood cell dysfunction[(8,9,10)].

Being rich sources of LDH, the acute liver injury and red blood cell destruction is followed by the release of LDH into the circulation. This finding has important implications because it highlights the potential of using serum LDH activity as an index in the monitoring of acute P. *falciparum* malaria infection, particularly when all other possible causes of increased serum LDH levels have been eliminated. Additionally, high serum LDH activity has also been reported in a variety of cancers, e.g. small cell carcinoma of the lung, nephroblastoma, neuroblastoma and metabolic neuroendocrine tumour[(11)]. Serum LDH is also increased in patients with measles and cervical lymphadenitis[(12)]. Furthermore, in monitoring the progress of diseases, LDH has been found to be relevant in establishing the survival duration and rate in Hodgkin's disease and non-Hodgkin's lymphoma, and in the follow-up of ovarian dysgerminoma[(13)]. LDH plays an important role in predicting response to therapy and prospects of remission in leukaemia and colon cancer[(14)] and as an important clue to the diagnosis of reactive haemophagocytic syndrome (RHPS) in febrile cytopenic patients with immunodeficiency[(15)] .

The present study aims to establish the role of serum LDH level as a bio-chemical marker in falciparum malaria patients for diagnosis, severity and treatment monitoring of the disease.

MATERIALS & METHODS

The Case-Control study was conducted in SCB Medical College & Hospital, Cuttack (In the South-Eastern part of India) during the period 2015-2016. Study group comprised 80 diagnosed complicated and 90 diagnosed uncomplicated falciparum malaria cases as per WHO 2000 guidelines. According to WHO the term severe complicated malaria is defined as the presence of one or more complication in a patient having asexual parasitaemia of P. f *alciparum* in the peripheral blood smear (World Health Organization: 2000). Age & sex matched 80 afebrile healthy individuals randomly selected from the outpatient department comprised the control group. Diagnosis of falciparum malaria was done by Giemsa stained peripheral blood smear and LDH based rapid diagnostic test. Cases of MI, Carcinoma, known liver diseases, Myopathy, Haemolytic Anaemia, AIDS, Renal diseases, Alcoholics and patients with anti-malaria drugs were excluded from study.

Routine investigation of blood haemoglobin (Acid Haematin method), DC, TLC ,Fasting plasma glucose (GOD-POD method),Serum sodium, potassium, Lipid profile , blood Urea, serum Creatinine, serum Bilirubin, AST, ALT, ALP were carried out in the study and control group. Kinetic assay of serum LDH enzyme was carried out according to the method described in Stroeve and Makarova, 1989 (Stoeve *et al*.1989) immediately after collection of blood samples. All the routine investigations were done by automated Clinical Analyzer Biolis24i Premium (Tokyo Boeki Machinery Ltd.). Results are expressed as mean ± standard error of the mean. The difference between the mean serumLDH activity in healthy and infected P. *falciparum* malaria patients was analysed by ANOVA.P-values of less than 0.05 were considered significant. Analysis of continuous variables was performed with Spearman correlations.

RESULTS

Table 1

Age in yrs	Uncomplicated malaria n=90	Complicated malaria==80
15-25	09(10%)	21(26.25%)
26-35	18(20%)	21(26.25%)
36-45	22(24.4%)	18(22.5%)
46-55	25(27.7%)	14(17.5%)
56-65	18(20%)	04(5%)
>65	8(8.88%)	02(2.5%)

The study included 250 participants among them 90 patients were uncomplicated malaria, 80 were complicated malaria and 80 were healthy controls. The mean age for control was 31.1yrs. The mean age for uncomplicated cases was 43.5 yrs and mean age for complicated cases was 36.3.

All age groups from 15 to 65 years were almost equally affected in malaria.

Table -1 shows in uncomplicated cases 10% of patents were less than 25 years.20% of patients were within 26-35 years age group, 24.4% of patients were within 36 to 45 years age group, 27.7% were 46 to 55 years, 20% were 56-65 years and 8.88% were more than 65 years of age. In complicated cases 26.25% of patents were less than 25 years.26.25% of patients were within 26-35 years age group, 22.5% of patients were within 36 to 45 years age group,17.5.% were 46 to 55 years, 5% were 56-65 years and 2.5% were more than 65 years of age.

Table 2 Gender Distribution of Control and Study Group

Subjects	Male	female	Total no.
Control	44(55%)	36(45%)	80
uncomplicated	46(51.11%)	44(48.88%)	90
Complicated	47(58%)	33(42%)	80

In our study males were more (55%) than females (45%) in control group. In uncomplicated malaria cases, males were (51.1%) compared to females (48.88%). In complicated malaria cases, males were 58% compared to females(42%).

Table 3 Cllinical Presentation of Patients With Malaria (n=170)

	No of cases	percentage
Fever	170	100%
Altered sensorium	54	31.7%
Convulsion	06	3.5%
Jaundice	72	42.35%
Oliguria	15	8.88%
Anaemia	95	55.8%

In malaria patients fever and jaundice were most common symptoms.anaemia were present in 55% of cases and 31.7% presented with altered sensorium.

No significant difference in total leucocyte count, serum sodium and serum potassium was seen between complicated malaria compared to control group except the random blood glucose which was significantly decreased in complicated malaria compared to control group.

ALP were significantly high in complicated malaria compared to uncomplicated malaria group.

Table 4 Biochemical Parameters in Controls And Cases

parameter	Control(n=80)	Uncomp malaria(n=90) mean±SD	comp malaria(n=80) mean±SD	P value
Total leucocyte count(mm3)	7210.43±1014.6	7830.38± 1132.6	7875.416 ±1411.1	0.853(control vs complicated)
Random blood glucose(mg/dL)	118± 18.2	98.8 ±25.4	78±7.8	<.0001(control vs complicated)
Serum sodium(meq/l)	140± 8.2	136±6.440	136.54±4.68	0.741(control vs complicated)
Serum potassium(meq/l)	3.4± 0.34	4.02 ±0.643	3.725±0.43	0.274 (control vs complicated)

Table 5 Biochemical Parameters In Controls And Uncomplicated Cases

	Control(n=80) mean±SD	Uncomplicated malaria(n=90) mean±SD	P value
Haemoglobin(gm%)	13.2±1.01	10.9±0.63	<0.001
Serum bilirubin(mg/dl)	0.74±0.16	1.25± 0.36	<0.003
AST(U/L)	32.7± 7.7	41.03±0.75	<0.001
ALT(U/L)	38±79	54.28±8.46	<0.002
ALP(U/L)	64.87±7.34	118.87±17.34	<0.001
Serum urea(mg/dl)	23±6.7	43± 13.7	<0.005
Serum cratinine(mg/dl)	0.81±0.27	1.31±0.27	<0.001

Table 5 shows haemoglobin percentage is significantly low in uncomplicated cases compared to control group. Serum urea, creatinine, serum bilirubin, AST, ALT, ALP were significantly high in uncomplicated malaria compared to control group.

Table 6 Biochemical Parameters in Controls and Complicated Cases

	Control(n=80) mean±SD	complicated malaria(n=80) mean±SD	P value
Haemoglobin(gm%)	13.2±1.01	5.6±0.50	<0.001
Serum bilirubin(mg/dl)	0.74±0.16	5.04± 1.52	<0.003
AST(U/L)	32.7± 7.7	325±22	<0.001
ALT(U/L)	38±79	337±20.75	<0.002
ALP(U/L)	64.87±7.34	358.7±35.56	<0.001
Serum urea(mg/dl)	23±6.7	217± 24.6	<0.005
Serum cratinine(mg/dl)	0.81±0.27	4.32±1.42	<0.001

Table 6 shows haemoglobin percentage is significantly low in complicated cases compared to control group. Serum urea, creatinine, serum bilirubin, AST, ALT, ALP were significantly high in uncomplicated malaria compared to control group.

Table 7 Comparision of Biochemical Parameters In Uncomplicated Malaria And Complicated Malaria

	Uncomplicated (n=90) mean±SD	complicated malaria(n=80) mean±SD	P value
Haemoglobin(gm%)	10.9±0.63	5.6±0.50	<0.001
Serum bilirubin(mg/dl)	1.25±0.36	5.04± 1.52	<0.001
AST(U/L)	41.03± 0.75	325±22	<0.001
ALT(U/L)	54.28±8.46	337±20.75	<0.001
ALP(U/L)	118.87±17.34P	358.7±35.56	<0.001
Serum urea(mg/dl)	43±13.7	217± 24.6	<0.001
Serum cratinine(mg/dl)	1.31±0.27	4.32±1.42	<0.001

Table 7 shows mean haemoglobin of uncomplicated malaria is 10.9±0.63and mean haemoglobin value of complicated malaria is5.6±0.50.Haemoglobin value is significantly decreased in complicated malaria group to uncomplicated malara group(p=0.001). serum urea, creatinine, bilirubin, AST, ALT,

Table 8 Serum LDH Analysis in Patients with Uncomplicated Malaria, Complicated Malaria And Controls

	LDH(U/L) (mean±standard deviation)	P value	
Uncomplicated Malaria(n=90)	778±68.3	VS control<0.0001	P value uncomplicated with complicated malaria<0.001
Complicated Malaria(n=80)	1778 ±221	VS control<0.001	
Control(n=80)	399 ±71.2		

Mean LDH values in uncomplicated malaria is 778 ±68.3U/L.mean LDH values in complicated malaria is 1778±221U/L.mean LDH values in control is 399±71.1U/L.
P value of LDH in uncomplicated compared to control group <0.0001.p value of LDH in complicated compared to control group is p=<0.0001.p value of LDH in complicated compared to uncomplicated malaria cases is p=<0.0001.

Table 9 Correlation of LDH With Haemoglobin And Creatinine In Uncomplicated Cases

Parameter	r value	P value
haemoglobin	-0.599	<0.0001
Creatinine	0.649	<0.0001

Above table shows correlation study of LDH with haemoglobin and creatinine in uncomplicated malaria cases. With haemoglobin it shows a significant negative correlation (p value <0.0001 and r value -0.599). With creatinine it shows a positive correlation which is statistically significant (p value <0.0001 and r value 0.649).

Table 10 Correlation of LDH With Haemoglobin And Creatinine In Complicated Cases

Parameter	r value	P value
haemoglobin	-0.975	<0.0001
Creatinine	0.960	<0.0001

Above table shows correlation study of LDH with haemoglobin and creatinine in complicated malaria cases. With haemoglobin it shows a significant negative correlation (p value <0.0001 and r value -0.975).With creatinine it shows a positive correlation which is statistically significant (p value<0.0001 and r value 0.960).

Table 11 Correlation of LDH With Bilirubin,Alt And Ast In Uncomplicated Cases

Parameter	r value	P value
Bilirubin	0.575	<0.0001
ALT	0.610	<0.0001
AST	0.671	<0.0001

Table 11 show correlation study of LDH with Bilirubin, ALT and AST in uncomplicated malaria cases.With bilirubin it shows a significant positive correlation which is statistically significant.(p value <0.0001and r value 0.575). With ALT it shows a statistically a significant positive correlation (p value <0.0001and r value 0.610). With AST it shows a statistically a significant positive correlation (p value <0.0001and r value 0.671).

Table 12 Correlation of LDH With Bilirubin,Alt And Ast In Complicated Cases

parameter	r value	P value
bilirubin	0.985	<0.0001
ALT	0.878	<0.0001
AST	0.961	<0.0001

Table 12 show correlation study of LDH with Bilirubin, ALT and AST in complicated malaria cases. With bilirubin it shows a significant positive correlation which is statistically significant. (p value <0.0001and r value 0.985). With ALT it shows a statistically a significant positive correlation (p value <0.0001and r value 0.878). With AST it shows a statistically a significant positive correlation (p value <0.0001and r value 0.9631).

DISCUSSION

Thirty-five years ago, Neely and colleagues elegantly demonstrated in patients with sickle cell disease that serum LDH was elevated, it was related to plasma hemoglobin level, and that both increased during Vasoocclusive crisis. They also demonstrated an LDH isoenzyme pattern supporting intravascular hemolysis as the principal source of elevated total serum LDH levels [16,17,18] since the pathogenesis of malaria involves both the liver and red blood cells [19]. The present study of lactate dehydrogenase (LDH) in falciparum malaria cases was carried out to assess serum LDH level and the association with multiple markers of haemolysis to predict the disease severity.

In malaria group males were more than females [Table-1]. But these data do not reflect the incidence and gender distribution of the disease in the community as the study was done only in a tertiary care hospital. However according to WHO malarial report 2009, males are more affected than females due to more exposure to mosquito bite for occupational reasons.The symptoms and signs observed were similar to other studies reported from India also.

Hemoglobin was significantly low in complicated malaria compared to control group [Table-2]. Anemia is common in severe malaria as the malaria parasites infecting man pass through a developmental phase in the parenchymal cells of the liver, reside in the red blood corpuscles and are carried to all the organs by the circulating blood. Later on there is increased destruction of red cells intravascularly by sequestration in the spleen leading to haemolysis [20]. Besides this, dyserythropoiesis was observed as an important factor for anemia of malarial origin. Hypersplenism was also observed as another important cause for anemia in malaria patients [21,22]. Severe malaria in adult is characterized by multiorgan failure. The commonly affected organs observed are CNS, kidney, and liver. In our study hepatic and renal involvement was common, this is justified by our findings of significantly high serum urea, creatinine, bilirubin, AST, ALT, ALP in complicated malaria compared to control groups. [Table-2] Our observations corroborate with observations published in other studies. Kocher *et al.* 2003 and Mishra *et al*. 1999 had also shown that there was significant rise in serum AST &ALT enzyme levels in falciparum infection with jaundice.

LDH was highly correlated with multiple markers of hemolytic severity.LDH was significantly inversely correlated with blood hemoglobin level (table-9,10). A statistically significant positive correlation of LDH with serum bilirubin AST, ALT and Creatinine (table-11,12) predicts the enzyme to be strongly associated with markers normally elevated in either hemolysis or liver disease. Alanine aminotransferase (ALT) is a highly specific marker of hepatocellular injury. Increase in total serum LDH level in complicated malaria may be due to haemolysis of RBC and destruction of hepatocytes which are the sources of LDH.

Although LDH1 and LDH2 isoenzymes can be released by cellular injury to cardiac muscle or kidney[23], the strong correlation with clinical markers of hemolytic severity in our results strongly implicates intravascular hemolysis as the dominant source of serum LDH in malaria patients.

This conclusion is further supported by association of elevated serum LDH levels with low levels of hemoglobin and high level of bilirubin. The disproportionate correlation to AST (p value <0.0001 & r value 0.961) more than ALT (p value <0.0001 & r value 0.878) is consistent with the higher concentration of AST compared to ALT in red blood cells, released during intravascular hemolysis[24,25].

These data begin to suggest that LDH elevation may be a marker of haemolysis. It is remarkable that LDH appears to predict a syndrome of hemolysis-associated endothelial dysfunction and risk of death in the killer disease of falciparum malaria.

CONCLUSION

The study entitled **"**Lactate Dehydrogenase (LDH) as a bio-chemical marker in falciparum malaria-a case control study in a tertiary care centre **"** was carried out to assess serum LDH level and the correlation with disease severity.

Males are more in number compared to females amongst malaria cases. Most common presentation was fever, anemia and icterus. Mean hemoglobin was significantly low in complicated malaria group compared to control group. Mean serum urea, creatinine, total bilirubin, AST, ALT, ALP were significantly higher in complicated malaria group compared to control group. The Serum LDH was significantly high in complicated malaria group compared to control group.LDH was highly correlated with multiple markers of hemolytic severity. LDH was significantly negatively correlated with hemoglobin level and significantly positively correlated with Serum bilirubin, ALT, AST and creatinine levels.

Thus, LDH appears to hold great promise as an effective prognostic indicator and biomarker of a haemolytic mechanism of vascular pathobiology in patients with malaria as a readily available clinical laboratory test.

References

1. Odhiambo, R. A., Odulaja, A. 2005.New enzymatic assay, parasite lactate 4dehydrogenase, in diagnosis of malaria in Kenya. *East African Medical Journal* 82(3):111-17.
2. Ranjit, M.R., Das, A., Das, B.P., Das, B.N., Dash, B.P., Chhotray, G.P. 2005. Distribution of Plasmodium falciparum genotypes in clinically mild and severe malaria cases in Orissa, India. *Transactions of the Royal Society of Tropical Medicine and Hygiene* 99: 389-395.
3. Patel, A.P., Henry, M.S., Sanjiv, K.2008. New Antimalarial Targets: The example of glucose transport; *Science Direct, Travel Medicine and infectious disease*6: 56-66.
4. Maegraith, B. 1981. Aspects of the pathogenesis of malaria. *Southeast Asian Trop Med Pub Health*12:251-67.
5. Sullivan, J.M., Alpers, J.P. 1971. In vitro regulation of rat heart 5'-nucleotidase by adenine nucleotides and magnesium. *J Biol Chem* 246:3057-63.
6. Podlasek, S.J., McPherson, R.A. 1989. Streptokinase binds lactate dehydrogenase subunit-M, which shares an epitope with plasminogen. *ClinChem- Am AssocClin Chem*35:69-73.
7. Calbreath, D.F. 1992. *Clinical Chemistry*: a fundamental textbook. Philadelphia: WB Saunders Company.
8. Wills, M.R., Harvey, Miller and Medcalf. 1971. The Biochemical Consequences of Chronic Renal Failure.New York.
9. Timmis, A.D., Nathan, A.W. 1993. Essentials of Cardiology. Oxford: Blackwell Scientific.
10. Castaldo, G., Oriani, G., Cimino, L., Topa, M., Mostarda, I., Castellano, L. 1994. Total discrimination of peritoneal malignant ascites from *ascites associated* with cirrhosis- and hepatocellular carcinoma associated ascites by assays of ascitic cholesterol and lactate dehydrogenase. *Clin Chem* 40:478-83.
11. Kanowski, D., Clague, A. 1994. Increased lactate dehydrogenase isoenzyme-1 in a case of glucagonoma. *ClinChem* 40:158-9.
12. Sugaya, N., Kanno, J., Nirasawa, M. 1990. Increased activities of cytosol aminopeptidase and lactate dehydrogenase in serum originate from lymphocytes in necrotizing lymphadenitis. *Clin Chem*36:304-6.
13. Pressley, R.H., Muntz, H.G., Falkenberry, S. 1992.Serum lactic dehydrogenase as a tumour marker in dysgerminoma. *Gynecol Oncol*4:281-3
14. Schwartz, M.K. 1992. Enzymes as prognostic markers and therapeutic indicators in patients with cancer. *ClinChim Acta* 206:77-82.
15. Koduri, P.R., Carandang, G., DeMarais, P. 1995.Hyperferritinemia in reactive hemophagocytic syndrome report of four adult cases. *Am J Hematol* 49:247-9.
16. Neely, C.L., Wajima, T., Kraus, A.P., Diggs, L.W., Barreras, L. 1969. Lactic acid dehydrogenase activity and plasma hemoglobin elevations in sickle cell disease. *Am J Clin Pathol*. 52: 167-169.
17. Naumann, H.N., Diggs, L.W., Barreras, L., Williams, B.J. 1971. Plasma hemoglobin and hemoglobin fractions in sickle cell crisis. *Am J Clin Pathol.* 56: 137-147.
18. Adhikary, P.K., Hara, S., Dwivedi, C., Davis, J.W., Weaver, C., Pavuluri, S.R. 1986. Vasoocclusive crisis episodes in sickle cell disease. *J Med* 17(3-4): 227-240.
19. White, N.J., Ho, M. 1992.The pathophysiology of malaria. *Adv Parasitol* 31:83-173
20. Woodruff, A.W., Ansdell, V.E., Peitt, E. 1979.Cause of anaemia in malaria. *Lancet* 1:1055-57
21. Clark, I.A., Chudhuri, G. 1988. Tumor necrosis factor may contribute to the anemia of malaria by causing dyserythropoisis & erythrophagocytosis. *Br. J. Haemato*.70:99-103.
22. Wenisch, C. B. Parschalk, E. N. 1995. Elevated serum levels of IL-10 and INF in patients with acute plasmodium falciparum malaria. *Clin. Immunopath*. 74:115-117.
23. Mishra, S.K., Satpathy, S.K., Mohanty, S. 1999. Survey of malaria treatment and deaths. *Bull WHO*77(12): 1020
24. Kato, G. J., McGowan, V., Machado, R. F., Little, J. A., Taylor VI, J., Morris, C. R., Nichols, J. S., Wang, X., Poljakovic, M., Morris Jr, S. M., Gladwin, M. T. 2006. Lactate dehydrogenase as a biomarker of hemolysis-associated nitric oxide resistance, priapism, leg ulceration, pulmonary hypertension, and death in patients with sickle cell disease. *BLOOD*107 (6): 2279-2285.
25. Kopperschlager, G., Kirchberger, J. 1996.Methods for the separation of lactate dehydrogenases and clinical significance of the enzyme. *J Chromatogr B Biomed Appl.* 684: 25-49.
26. Kocher, D.K.,Singh, P., Agarwal, P.,Kocher, S.K., Pokharna, R.,Sareen, P.K. 2003. Malarial Hepatitis. *JAsso.Physicians India*51:1069-1072
27. Saunders, W.B.1988. Haematology of infancy and childhood. *Br J Haematol*70:99-103.
28. Stroeve, E.A., Makarova, V.G. 1989. Laboratory Manual in Biochemistry. Moscow: MIR Publishers.
29. WHO Communicable Disease Cluster. Severe falciparum malaria.2000. *Trans R Soc Med Hyg*.
30. WHO malarial report, 2009.
31. World Health Organization, Division of Control of Tropical Diseases.1990.Severe and complicated malaria. *Trans R Soc Trop Med Hyg*84suppl 2:1-65.
32. World Malaria Report, 2008.WHO *malaria* report 2008.

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