Research Article

STUDY OF HEMATOLOGICAL, SEROLOGICAL AND BIOCHEMICAL PARAMETERS IN PATIENTS OF DENGUE VIRAL INFECTION

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Abstract:

Background: The acute febrile arboviral disease known as dengue fever is caused by the dengue virus, which belongs to the Flaviviridae family and the Flavi virus genus and is found in tropical and subtropical regions of the world.

Objective: to determine the seropositivity of dengue in patients attending tertiary care hospital and to comparatively evaluate the performance of rapid card in detection of dengue antigen and antibody along with correlation of biochemical parameters like SGPT and SGOT.

Methods: The study is conducted over a period of 1.5 years in the central laboratory of Dhiraj General Hospital, Piparia. A total of 100 patients were included. Blood samples were collected from the dengue patients at the time of admission. Peripheral smear analysis and complete blood count were performed on the blood samples. The serum was then tested for NS1, IgM and IgG using a Dengue antigen test kit and for SGPT and SGOT.

Results: 100 patients participated in the study. Of these, 26 were IgM-positive, 6 IgG- positive and 44 NS1-positive. The oldest patient was seventy years old, the youngest eighteen years old.

Conclusion: Young adults are particularly susceptible to dengue fever. The diagnosis is easy to make. There are several clinical and hematologic manifestations of this disease, and treatment and diagnosis can begin early.

Keywords: Dengue, NS1, IgM, IgG and atypical lymphocytes

INTRODUCTION

Dengue virus is recognized as one of the most important emerging tropical infectious diseases worldwide.[1] According to the WHO, dengue fever or dengue haemorrhagic fever is the second most important tropical disease after malaria.[2] In recent years, dengue has become a major international health problem. Every year, 100 million new dengue virus infections are reported worldwide, with 5 lakh cases of dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS). There are about

30000 deaths every year, most of them in children.[2] DHF/DSS is recognized as a major cause of mortality and morbidity in school children in tropical and subtropical countries.[3]

In India, dengue fever has been known for two centuries. In India, the virus was first isolated in 1945, with all four serotypes being endemic in India.[4] In South India, all 4 serotypes of dengue fever were isolated in Vellore between 1956 and 1960. Later, the disease was also reported from other parts of India.

Dengue virus is a single-stranded RNA virus with four serotypes. They are DEN1, DEN2, DEN3 and DEN4. Infection with one serotype of the dengue virus does not provide cross-protection against the other serotype.

Common diagnostic methods for dengue are virus isolation, RT-PCR and serologic methods. Virus isolation is a time-consuming and demanding process. That requires specialized laboratory equipment and experienced personnel. While RT-PCR significantly reduces processing time and detects the virus at an early stage, these methods remain expensive and technically difficult, especially in developing country laboratories.[5]

One of the most reliable methods for the diagnosis of early dengue infection is the detection of specific antigens that directly correlate with the underlying viremia and pathogenesis of the infection.[5]

There is no specific treatment or vaccine for dengue infection. Given the life-threatening complications and increased mortality rate, rapid and sensitive laboratory methods for early detection of the disease are essential. This helps to identify cases, initiate treatment as early as possible and reduce the complications associated with the disease. In addition to serologic parameters, the hematologic profile and biochemical tests are also helpful as diagnostic markers for the detection of dengue infection.

Considering the increased incidence of dengue and its complications, the study was conducted to determine the seropositivity of dengue in patients attending tertiary care hospital and to comparatively evaluate the performance of rapid card in detection of dengue antigen and antibody along with co-relation of biochemical parameters like SGPT and SGOT.

MATERIAL AND METHODS

This Cross sectional study was conducted among Patients attending OPD and IPD in Department of Pathology (Central Laboratory) Dhiraj Hospital and S.B.K.S. Medical College, Piparia, Vadodara

Sample Size: 100

INCLUSION CRITERIA:

Any patient, male or female, giving written informed consent and diagnosed as having Dengue Fever with serological confirmation done by rapid card method (immunochromatography).

- Testing positive for Dengue NS1 Antigen
- Presence of Antibodies (IgG/IgM) in serum against Dengue virus

EXCLUSIONCRITERIA

- Patients having other co-infections like Malaria, Enteric Fever, Urinary tract infection, pneumonia and other infection.
- Patients with known immune compromised status

Methodology:

COLLECTIONOFBLOOD SAMPLES

1. **Antigen test**
- The serum samples collected were subjected to the dengue check test which is rapid test system.

Immunochromatography card test (ICT):
- The Dengue check test is a rapid, qualitative immuno-chromatographic test for the differentiation between IgG and IgM antibodies against dengue virus in human serum or plasma and for the detection of dengue virus nonstructural (NS1) antigen. This test system is used as screening test for dengue viral infection and aid differential diagnosis of self-limiting primary Dengue infections and potentially fatal secondary Dengue infections in conjunction with other criteria.

InterpretationOfResult:

NegativeResults:

Onlyonepink/purple colouredbandappears atControlRegion 'C'ofboth DengueNS 1 &IgG/IgM devices.
ThisindicatesabsenceofdengueNS1antigen andIgG/IgMantibodiestodenguevirus in the specimen

Positive results:

- NS1 Antigen
Twopink/purplecolouredbandsappearatthe ControlRegion'C'andTestRegion'T'. This indicates that the specimen contains detectable level of Dengue NS 1 antigen.
- IgG/IgMAntibodies
In addition to the band in the control area

marked 'C', appearance of two pink-purple coloured bands in the test region 'G' and region 'M', indicates the presence of Dengue virus specific IgG and IgM antibodies.

In addition to the control band in the control area marked 'C', appearance of a pink- purple coloured band in the test region 'M', indicates the presence of Dengue virus specific IgM antibodies.

In addition to the control band in the control area marked 'C', the appearance of a pink- purple coloured band in the test region 'G', indicates the presence of Dengue virus specific IgG antibodies

Invalid results:

The test result is invalid if no bands appear on the device. The test should also be considered invalid if only the test band appears, and no control band appears. In such cases, verify the test procedure and repeat the test with a new device.

RESULTS

The majority of dengue patients in this study (n = 25) are between the ages of 21 and 30 (33%), with the next largest age group being 31 to 40 (25%). Age groups 51–60 years old (7%) and 61–70 years old (2%), however, are the least represented. Younger persons have a greater rate of dengue infection, according to the findings.

With 52% male and 48% female, dengue patients in this research are somewhat more male. Dengue infection seems to be equally distributed across men and women

Table 1: Distribution of patients according Serological classification of dengue positive cases

			n	%
Single positive	**NS1**	Negative	23	23.00

		WeakPositive	2	2.00
		Positive	75	75.00
	IgM	Negative	67	67.00
		WeakPositive	5	5.00
		Positive	28	28.00
	IgG	Negative	90	90.00
		WeakPositive	2	2.00
		Positive	8	8.00

The NS1 antigen test showed 75% positive, 23% negative, and 2% weak positive, suggesting a high incidence of acute dengue infection. In terms of IgM antibodies,67% of patients were negative, 5% were weak positive, and 28% were positive for recent infection. IgG antibodies, which indicate prior infection or secondary infection, were negative in 90%, weak positive in 2%, and positive in 8%. This data shows that most patients had an acute primary infection, with a lesser percentage having recent or previous illness.

Table 2: Distribution of patients according Bivariant analysis between NS1 and IgM

		IgM							
		Negative		**WeakPositive**		**Positive**		**Total**	
		n	%	n	%	n	%	n	%
NS1	Negative	4	5.97	4	80.00	15	53.57	23	23.00
	WeakPositive	2	2.99	0	0.00	0	0.00	2	2.00
	Positive	61	91.04	1	20.00	13	46.43	75	75.00
	Total	67	100	5	100	28	100	100	100

5.97% of NS1-negative people were IgM-negative, 80.00% were IgM weak positive, and 53.57% were IgM positive. 2.99% of weak positive NS1 patients were IgM negative, with no IgM weak positive or positive cases. NS1-positive individuals were 91.04% IgM negative, 20.00% IgM weak positive, and 46.43% IgM positive. This distribution shows the relationship between NS1 positive and IgM antibody levels.

Table 3: Distribution of patients according to Bivariant analysis between NS1 and IgG

		IgG							
		Negative		**Weak Positive**		**Positive**		**Total**	
		n	%	n	%	n	%	n	%
NS1	Negative	**15**	16.67	**2**	100.00	**6**	75.00	**23**	23.00
	Weak Positive	**2**	2.22	0	0.00	0	0.00	2	2.00
	Positive	**73**	81.11	0	0.00	2	25.00	75	75.00
	Total	90	100.00	2	100.00	8	100.00	100	100.00

Dengue patients' NS1 antigen and IgG antibody statuses were bivariately analyzed in this table. Of those who were NS1 negative, 16.67% were IgG negative, 100.00% were IgG weak positive, and 75.00% were IgG positive. In weak positive NS1 instances, 2.22% were IgG negative and none were IgG positive. In NS1 patients, 81.11% were IgG negative, no IgG weak positives, and 25.00% IgG positive. This distribution shows the association between NS1 positive and IgG antibody levels, suggesting initial or secondary infection.

The average hemoglobin level was 11.852 g/dL, with a median of 12.2 and a standard deviation of 2.304869 and a range of 6.6 to 16.7, indicating some individuals had anemia. A mean RBC count of 4.47 million cells/µL was close to the median of 4.46, although variability was present with a standard deviation of 0.80 and a range of 2.50 to 6.91 million cells/µL, suggesting bone marrow suppression in some individuals. The mean MCV was 80.869 fL, with a median of 82.5 fL and a range of 8.3 to 102.9 fL, indicated by a standard deviation of 11.05952. Red blood cell sizes varied. The MCH had a mean of 26.585 pg and a median of 26.85 pg, with a standard deviation of 3.480113 and a range of 17 to 38.2 pg, suggesting hemoglobin concentration per red blood cell.

MCHC averaged 32.509 g/dL with a median of 32.7 and a low standard deviation of 2.024801, ranging from 26.3 to 38 g/dL, demonstrating steady red blood cell hemoglobin content. The range of white blood cell counts in patients ranged from 2000 to 516000 cells/µL, indicating leukocytosis or leukopenia. The mean was 11711 cells/µL, the median was 5000, and the standard deviation was 51264.98. Average neutrophil percentages were 63.32%, with a median of 62%, a standard deviation of 12.18285, and a range of 40% to 93%, demonstrating different immunological responses. The mean lymphocyte percentage was 29.43%, the median was 30.5%, and the standard deviation was 11.84006, ranging from 2% to 50%, possibly due to viral infection effects.

The standard deviation was 1.003831 and the range was 1% to 6% for eosinophil percentages, which averaged 3.32% with a median of 4%. The mean monocyte percentage was 4.13%, the median was 4%, and the standard deviation was 1.44708, ranging from 1% to 10%, suggesting immunological responses. The mean platelet count was 130060.6 cells/µL, with a median of 100000, a high standard deviation of 100269.6, and a broad range of 2000 to 450000 cells/µL,

showing substantial thrombocytopenia in many individuals. The hematocrit averaged 37.026%, with a median of 38%, a standard deviation of 7.335063, and a range of 18.7% to 57.1%, indicating red blood cell volume variability.

Liver function tests indicated that SGPT levels had a mean of 120.99U/L, a median of 22, an unusually high standard deviation of 681.8245 and a range of 10 to 6716 U/L, suggesting liver impairment. SGOT values ranged from 12 to 15088U/L, with a mean of 211.66U/L, a median of 24, and a standard deviation of 1508.27, showing substantial liver involvement in some individuals. Together, these measures show the hematological and biochemical effects of dengue infection and the vast spectrum of physiological responses in individuals.

Table 4: Details of biochemical parameter of the patients

	Mean	Median	Std. Deviation	Minimum	Maximum
Hemoglobin	11.852	12.2	2.304869	6.6	16.7
RBCmass	4.47	4.46	0.80	2.50	6.91
MCV	80.869	82.5	11.05952	8.3	102.9
MCH	26.585	26.85	3.480113	17	38.2
MCHC	32.509	32.7	2.024801	26.3	38
TotalCounts	11711	5000	51264.98	2000	516000
Neutrophil	63.32	62	12.18285	40	93
Lymphocyte	29.43	30.5	11.84006	2	50
Eosinophil	3.32	4	1.003831	1	6
Monocytes	4.13	4	1.44708	1	10
Platelets	130060.6	100000	100269.6	2000	450000
Hematocrit	37.026	38	7.335063	18.7	57.1
SGPT	120.99	22	681.8245	10	6716
SGOT	211.66	24	1508.27	12	15088

Total WBC Counts

WBC counts of 3000-3900 cells per cubic millimeter were most common in 23% of individuals. The next most prevalent ranges were 4000-4900cells/cumm (20%)and ≥10,000 cells/cumm(15%). Other values are5000-5900 cells/cumm (11%), 2000-2900 (6%),9000-9900(6%),7000-7900(9%),6000-6900(7%),and8000-8900(3%).This distribution shows that many dengue patients had reduced WBC counts, demonstrating the virus's immune system effect.

Most patients (36%) had platelet counts above 120,000 per cm3. The next most prevalent platelet count ranges were≤20,000(9%) and71,000-80,000 percumm(9%). 21,000-30,000(2%),31,000-40,000(6%),41,000-50,000(4%),51,000-60,000(7%), 61,000-70,000(3%),81,000-90,000(5%),91,000-100,000(8%),101,000-110,000 (4%), and 111,000-120,000 (7%).

Platelet counts vary widely, with a considerable number of individuals developing dengue-related thrombocytopenia.

Atypical lymphocytes and other parameters with atypical lymphocytes

Unusual lymphocytes in patient peripheral smears. Atypical lymphocytes were seen in 31% of patients and absent in 69%. In dengue virus infections, atypical cells help diagnose and explain the immune response.

Table 5: Association of Atypical lymphocytes in with total count

	ATYPICALLYMPHOCYTESINPS				Chi Sq.	p-Value
	Yes		No			
TCcellspercumm	n	%	n	%		
2000-2900	2	6.45	4	5.80	11.40	0.180
3000-3900	12	38.71	11	15.94		
4000-4900	6	19.35	14	20.29		
5000-5900	1	3.23	10	14.49		
6000-6900	3	9.68	4	5.80		
7000-7900	1	3.23	8	11.59		
8000-8900	0	0.00	3	4.35		
9000-9900	1	3.23	5	7.25		
≥10,000	5	16.13	10	14.49		
Total	31	100	69	100		

For individuals with atypical lymphocytes, 38.71% had WBC counts of 3000-3900 cells percubicmillimeter(cumm),followedby19.35%at4000-4900.WBCcountsinthe4000-4900 cells/cumm range were greatest in patients without unusual lymphocytes (20.29%), followed by 15.94% in the 3000-3900 range. At the standard 0.05 significance level, the chi-square value of 11.40 with a p-value of 0.180 shows no statisticallysignificantcorrelationbetweenatypicallymphocytesandtotalWBCcount.

This implies that dengue patients' atypical lymphocytes are not highly correlated with WBC count ranges.

Table6:**Associationof AtypicallymphocytesinwithPlatelets(percumm)**

	ATYPICALLYMPHOCYTESINPS				Chi Sq.	p-Value
	Yes		No			
Platelets(percumm)	n	%	n	%		

≤20000	6	19.35	3	4.35	16.40	0.127
21000-30000	1	3.23	1	1.45		
31000-40000	1	3.23	5	7.25		
41000-50000	3	9.68	1	1.45		
51000-60000	4	12.90	3	4.35		
61000-70000	0	0.00	3	4.35		
71000-80000	2	6.45	7	10.14		
81000-90000	2	6.45	3	4.35		
91000-100000	2	6.45	6	8.70		
101000-110000	1	3.23	3	4.35		
111000-120000	1	3.23	6	8.70		
>120000	8	25.81	28	40.58		
Total	31	100	69	100		

Themajorityofindividualswithatypicallymphocytes (25.81%) had platelet counts over 120,000 per cubic millimeter (cumm), whereas 19.35% had levels below 20,000 per cumm. In patients without unusual lymphocytes, 40.58% had platelet counts over 120,000 per cumm, whereas only 4.35% had levels below 20,000 per cumm. At the 0.05 significance level, the chi-square value of 16.40 with a p-value of 0.127 shows no statisticallysignificant connection between atypical lymphocytes and platelet counts. This implies that dengue patients' atypical lymphocytes are not highly correlated with platelet count ranges.

The mean hemoglobin levels for patients with and without atypical lymphocytes were 12.36 g/dL and 11.62 g/dL, respectively,withnosignificantdifference(p=0.139).Erythrocytemassshowedalarge discrepancy in the standard deviation in patients without atypical lymphocytes due to an outlier, resulting in no significant difference (p=0.519). The mean corpuscular volume(MCV)andmeancorpuscularhemoglobin(MCH)weresimilarinbothgroups and showed no significant differences (p=0.330 and p=0.769, respectively).

The total white blood cell count showed higher variability, but did not differ significantly between the groups (p=0.115). The percentage of neutrophils was significantly lower in patients with atypical lymphocytes (55.35%) than in those without (66.90%) (p<0.001). Conversely, the percentage of lymphocytes was significantly higher in patients with atypical lymphocytes (37.32%) than in patients withoutatypicallymphocytes(25.88%)(p<0.001).Thepercentagesofeosinophilsand monocytes did not differ significantly (p=0.401 and p=0.179 respectively).

Plateletcountswerelowerinpatientswithatypicallymphocytes,butthedifferencewas not statistically significant (p=0.231). Hematocrit levels were similar between groups (p=0.197).Liverenzymelevels(SGPTandSGOT)weresignificantlyhigherinpatients withatypicallymphocytes,withSGPTshowingasignificantdifference(p=0.044)and SGOT approaching significance (p=0.078). These data indicate specific

hematologic and biochemical differences associated with the presence of atypical lymphocytes in dengue patients.

This table shows how dengue patients' biochemical indicators relate to NS1 antigen status.NS1negativepatientshadameanhemo globinlevelof11.10g/dL,whereasNS1positi vepatientshad12.08g/dL,withat-valueof-1.80andap-valueof0.074,showing a tendency towards significance but not statistical significance at the 0.05 level. ThemeanRBCmassforNS1negativepatients was4.26millioncells/μL,whereasNS1 positive patients had 4.54 million cells/μL, with a t-value of -1.47 and a p-value of 0.146, indicating no MCV, MCH, and MCHC values were comparable across groups with p-values of 0.853, 0.657, and 0.991.

NS1 positive patients had on average greater total white blood cell counts (12883.12 cells/μL) than NS1 negative patients (7786.96 cells/μL), although the difference was not significant(p=0.678).With p-values of 0.990 and 0.840,neutrophilandlymphocyte percentages were similar across groups.

With p-values of 0.535 and 0.328, NS1 negative and positive groups had similar eosinophil and monocyte percentages. NS1 positive patients had somewhat lower platelet counts (126473.68cells/μL) than NS1 negative patients (141913.04 cells/μL), but the difference was not significant (p=0.520).

NS1 positive patients had higher hematocrit levels (mean 37.85%) than NS1 negative patients (mean 34.25%), p-value 0.038. Liver enzymes SGPT and SGOT exhibited greater means in NS1 positive patients (146.12U/L and 261.79U/L) than NS1 negative patients (36.87 U/L and 43.83 U/L), although these differences were not statistically significant (p-values of 0.503 and 0.546).

Table 7: Association of biochemical parameters with NS1

	NS1				t	p-Value
	Negative		**Positive**			
	Mean	**±SD**	**Mean**	**±SD**		
HEMOGLOBIN	11.10	2.63	12.08	2.17	-1.80	0.074
RBCMASS	4.26	1.00	4.54	0.73	-1.47	0.146
MCV	80.49	8.98	80.98	11.66	-0.19	0.853
MCH	26.30	3.70	26.67	3.43	-0.45	0.657
MCHC	32.51	2.04	32.51	2.03	0.01	0.991
TOTAL COUNTS	7786.96	3482.59	12883.12	58428.42	-0.42	0.678
NEUTRO	63.35	11.62	63.31	12.42	0.01	0.990
LYMPHO	29.87	11.27	29.30	12.07	0.20	0.840
EOSINOPHILS	3.43	1.04	3.29	1.00	0.62	0.535
MONOCYTES	3.87	1.10	4.21	1.53	-0.98	0.328
PLATELETS	141913.04	115859.21	126473.68	95622.10	0.65	0.520
HEMATOCRIT	34.25	8.54	37.85	6.78	-2.10	0.038

SGPT	36.87	36.49	146.12	776.15	-0.67	0.503
SGOT	43.83	46.65	261.79	1718.03	-0.61	0.546

This table shows how the IgM status influences the biochemical parameters of dengue patients. The mean hemoglobin level for IgM-negative patients was 12.24 g/dL, compared to11.06 for IgM-positive patients, with at-value of 2.47 and a p-value of

0.015. The mean erythrocyte mass was significantly greater in IgM-negative patients (mean 4.62 million cells/µL) than in IgM-positive patients(4.19 million cells/µL),with a p-value of 0.011.

The mean corpuscular volume (MCV) and hemoglobin (MCH) of the two groups were identical, with p-values of 0.570 and 0.581, respectively. The mean corpuscular hemoglobin concentration (MCHC) of the groups was also similar (p=0.148).

In the IgM-positive individuals, the total white blood cell count fluctuated more, although not significantly (p=0.150). The percentages of neutrophils and lymphocytes were similar in all groups, with p-values of 0.131 and 0.119, respectively.

Eosinophil and monocyte percentages were also similar, with p-values of 0.590 and 0.966. Although not statistically significant, IgM-positive individuals had lower platelet counts (p=0.598).

IgM-negative patients had higher haematocrit (mean 38.47%) than IgM-positive patients (mean 34.09%), p-value 0.004. IgM-negative individuals had higher liver enzyme levels (SGPT and SGOT), although the differences were not statistically significant (p- values of 0.343 and 0.409, respectively).

The mean hemoglobin level for IgG-negative patients was11.75g/dL, compared to12.79 for IgG-positive patients, with at-value of-1.36 and a p-value of 0.176.The red blood cell mass was significantly greater in IgG-positive patients (mean 5.00 million cells/µL) compared to IgG-negative patients (4.42 million cells/µL) (p-value 0.030).

The mean corpuscular volume (MCV) and hemoglobin (MCH) of the two groups were identical (p-value 0.938 and 0.496, respectively). The mean corpuscular hemoglobin concentration (MCHC) of the groups was also similar (p=0.201).

The total white blood cell count was similar in the groups (p=0.724). The mean percentage of neutrophils was 55.90% in IgG-positive subjects compared to 64.14 in IgG-negative patients (p=0.042). In contrast, IgG-positive patients had a significantly higher percentage of lymphocytes (mean 37.20%) than IgG-negative patients (mean 28.57%) (p=0.028).

The proportion of eosinophils and monocytes was also similar, with p-values of 0.692 and 0.123. In IgG-positive individuals, the number of platelets was reduced, although not significantly (p=0.312).

IgG-positive patients had higher hematocrit levels (mean 40.38%) than IgG-negative patients (mean 36.65%), although the difference was not statistically significant (p=0.128). Liver enzyme levels (SGPT and SGOT) did not change between the groups (p-values of 0.717 and 0.727).

DISCUSSION

In this research, the biggest proportion of dengue patients (n = 25) falls within the age range of 21 to 30, accounting for 33% of the total. The second highest age group is 31 to 40, including 25% of the patients. Our finding was supported by several previous studies.

In our study, the proportion of male dengue patients is slightly higher at 52%, while the proportion of female patients is 48%.

In our study the NS1 antigen test produced a 75% positive rate, a 23% negative rate, and a 2% weakly positive rate. These findings indicate a large prevalence of acute dengueinfection. Out of the patients, 67% tested negative for IgM antibodies,5%had strongly positive results, and 28% had positive results indicating recent -62.0 infection. 90% of individuals tested had negative results for IgG antibodies, suggesting no prior or secondaryinfection. In 2% of cases, the results were strongly 0 positive, while in 8% of cases, the results were positive.Most patients had an acuteprimaryinfection, whereas a smaller number had a recent or prior illness. The research further discovered that people who tested negative for NS1 had a distribution of antibodies that were negative for IgM, had low levels of IgM, and were high for IgM. On the other hand, people who tested positive for NS1 exhibited a range of antibodies that were negative for IgM, mildly positive for IgM, and positive for IgM. An observation was made about the correlation between NS1-positive and IgM antibody levels. Conversely, those who tested negative for NS1 had a range of antibodies including IgG-negative, IgG-weakly positive, and IgG-positive. The research indicates a correlation between NS1-positive and IgG antibody levels, suggesting the presence of either a primary or secondary infection. According to Rajeevan et al.(2020), individuals who tested positive for IgM, IgG, or NS1Ag antibodies against the dengue virus were classified as members of the dengue-positive category.

Hemoglobin levels

Our investigation revealed that the average hemoglobin level was 11.852 g/dL, suggesting the presence of anemia in some people.

Erythrocyte count

Our study found that the average red blood cell (RBC) count was 4.47 million cells per microliter (μL), indicating bone marrow suppression in some people. Rajeevan et al (2020) reported comparable results.

Mean corpuscular volume (MCV)

Our study showed that the mean MCV was 80.869 fL, ranging from 8.3 to 102.9 fL. The differences in red blood cell size in dengue patients may be due to various factors, such as inadequate nutrition, bone marrow response to infection, or red blood cell break down. Accurate determination of MCV levels can help to distinguish between acute changes caused by dengue and pre-existing disease.

Red blood cell size and mean corpuscular hemoglobin (MCH)

Red blood cell diameters showed variation, with a mean MCHvalueof26.585 pg and a mean MCV value of 26.85 pg. The mean MHC value was 32.509 g/dL, indicating a constant hemoglobin content in the red blood cells. The constancy of MCH and MHC levels is consistent with the results of previous studies, including those of Rajeevan et al. (2020).

White blood cellcount (WBC)

Ourstudyshowedthatin23%ofpatients,thewhitebloodcellcountwasbetween3000 and 3900 cells per cubic millimeter, which was the most commonly observed range. Thefollowingvalueswerealsoobserved:4000-4900cells/cubicmillimeter,accounting for20%ofcases,and $\geq$10,000cells/cubicmillimeter,accountingfor15%ofcases.

Dengue often leads to leukopenia as the virus directly attacks the bone marrow and causes a loss of white blood cells. ResearchbyBhattaraietal.(2023)andotherstudieshaveshownthatleukopenia,especially when accompanied by monocytosis or lymphopenia, is a characteristic hematologic observation in dengue.

Ofthepatientswithatypicallymphocytes,38.71%hadawhitebloodcell(WBC)count between 3000 and 3900 cells per cubic millimeter (cumm), while 19.35% had a count between4000and4900cells/cumm.Thehighestwhitebloodcell(WBC)countof4000 to 4900 cells per cubic millimeter (cumm) was found in patients who had no atypical lymphocytes, representing 20.29% of cases. This was followed by a percentage of 15.94% in patients with a WBC count between 3000 and 3900. There is no statistically significant association between atypical lymphocytes and total white blood cell count.

Lymphocytesandmonocytes

Our study showed that the mean lymphocyte percentage was 29.43%, which could be due to the effects of viral infection. The average monocyte percentage was 4.13%, indicatingtheinvolvementofmonocytesinantigenpresentationaspartoftheimmune response. Bhattarai et al. (2023) and

Chaloemwong et al. (2018) documented comparable results.

Bloodplatelet count

Our study showed that the majority of patients (36%) had a platelet count of over 120,000percm³.Thesubsequentmostcommonplateletcountwere20,000orless(9%)and between 71,000 and 80,000 per cubic centimeter (9%).

Thereis considerablevariationinthedistributionofplateletcounts,withasignificantproportion of people associated with dengue having thrombocytopenia. SubhaschandraKadadavaretal.(2020)alsodocumentedan increased incidence of thrombocytopenia and emphasized the need for careful platelet monitoring and intervention to avoid hemorrhagic consequences. Ofpeoplewithatypicallymphocytes,25.81% hadaplateletcountofover 120,000per cubicmillimeter(cumm),while19.35%had acountoflessthan20,000 percumm.Of thepeoplewhodidnothaveatypicallymphocytes,40.58%hadaplateletcountofover 120,000 per cubic millimeter, while only 4.35% had a count of less than 20,000 per cubicmillimeter.Thereisnostatisticallysignificantassociationbetween atypical lymphocytes and platelet count.

Hematocritlevels

Our study showed that hematocrit had an average value of 37.026%, suggesting that thereisvariationinredbloodcellvolume.Hemoconcentration,characterizedbyanelevated hematocrit, is a sign of plasma leakage and increased vascular permeability. StudiesbySubhaschandraKadadavaretal.(2020) and Joshiet al. confirm these conclusions.

Liverfunctiontests (LFTs)

Our study found that liver function tests revealed an SGPT value of 120.99 U/L and SGOT values between 12 and 15,088 U/L, indicating liver dysfunction. Elevated transaminaselevels,especiallyAST,arefrequentlyobserved indenguecasesandmay indicateliverinvolvementordamagetootherorgans.InastudyconductedbyBhattarai etal.in2023,itwasfoundthatthemeanincreaseinALT,ASTandALPwasstrongly linked with the group of individuals who tested positive for dengue. However, an independent association was only found for AST. Therefore, injury to non-liver tissue may also cause an increase in AST levels relative to ALT levels [Green et al. 2013].

Our study showed that hyperglycemia is a medical condition characterized by high levels of glucose (sugar) in the blood. Bhattarai et al (2023) observed that hyperglycemiawasprevalentinindividualswithdenguefever,andthiswascausedby the stress of high blood glucose levels.

Atypical lymphocytes

Ourstudyshowedthat31%ofpatientshadabnormallymphocytes,whiletheremaining 69% had none. Atypical lymphocytes serve as an important diagnostic indicator in dengue virus infections and help to understand the immune response. Yadav and Choudhary et al. have made similar discoveries regarding atypical lymphocytes.

Hemoglobinvalues

Themeanhemoglobinlevelsforpatientswith andwithoutatypicallymphocyteswere

12.36g/dLand11.62 g/dL, respectively.

Whileindividualswithatypicallymphocytes had slightly higher hemoglobin levels, the difference did not reach statistical significance(p=0.139).Thisindicatesthatthe presenceofatypicallymphocyteshasno significant effect on hemoglobin levels in individuals with dengue.

Hematocritandredbloodcellvariation

The standard deviation of red blood cell mass showed a significant disparity in the individualswithoutabnormallymphocytes, whichwasmainlyduetothepresenceof1 outlier. Therefore, no statistically significant difference was found between the two groups (p=0.519). This indicates that the total red blood cell count is not appreciably affected by the presence of abnormal lymphocytes.

Mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) are two measures that can be used to assess the size and amount of hemoglobin in red blood cells.

No significant differences were found between the two groups in terms of mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH), as shown by the p-values of 0.330 and 0.769, respectively.

The total leukocyte count showed greater variation, but there was no statistically significantdifferencebetweenthosewithand withoutatypicallymphocytes(p=0.115).

The results of Kalabamu et al (2021) indicate that leukopenia is common in dengue patients compared to febrile individuals without dengue, which is consistent with our findings.

Ofthepatientswithatypicallymphocytes,38. 71%hadawhitebloodcell(WBC)count between 3000 and 3900 cells per cubic millimeter (cumm), while 19.35% had a

count between 4000 and 4900 cells/cumm. The highest white blood cell (WBC) counts, between 4000 and 4900 cells per cubic millimeter (cumm), were found in individuals who had no atypical lymphocytes, which represented 20.29% of the total. This was followedbyacount of15.94%in therangeof 3000to3900 cellspercubicmillimeter.

There is no statistically significant correlationbetweenatypicallymphocytesan dtotalwhitebloodcellcount.Thus,there is a low correlation between the presence of atypical lymphocytes in dengue patients and the range of white blood cell counts.

Neutrophilsandlymphocytes

Therewerecleardifferencesintheproportions ofneutrophilsandlymphocytesbetween the two groups. Patients with abnormal lymphocytes had a significantly lower proportionofneutrophils(55.35%)compared topatientswithoutatypicallymphocytes (66.90%)($p<0.001$). Incontrast, theproportionoflymphocyteswassignificantl yhigher in those with atypical lymphocytes (37.32%) compared to those without (25.88%) ($p<0.001$).Choudhary et al. (2011) and Musso et al. (2019) found that lymphopenia is a strong indicator of dengue-positive results.

Eosinophils and monocytes

There was no significant difference in the proportions of eosinophils and monocytes between patients with and without atypical lymphocytes ($p=0.401$ and $p=0.179$, respectively). This indicates that the presence of atypical lymphocytes have no significant effect on the levels of these particular types of white blood cells.

The majority of patients (36%) had platelet counts over 120,000 per cm³.Thesubsequentmostcommonplateletco untrangeswerelessthanorequalto20,000 (9%) and between 71,000 and 80,000 per cubic centimeter (9%).

Whilepatientswithatypicallymphocyteshad lower plateletcounts,theobserveddifferencedidnot reachstatisticalsignificance($p=0.231$). The presenceofatypicallymphocytesdoesnothav e a substantialimpactonplateletlevels. Amongpeoplewithatypicallymphocytes,25. 81%hadplateletcountsover120,000per cubicmillimeter(cumm),whereas19.35%ha dcountsbelow20,000percumm.Among individuals who did not have atypical lymphocytes, 40.58% had platelet counts over 120,000 per cubic millimeter, while only 4.35% had counts below 20,000 per cubic millimeter.Thereisnostatisticallysignificant associationbetween atypical lymphocytes and platelet counts.

Hematocritlevelsrefertothepercentageofred bloodcellsinthetotalvolumeofblood. The hematocrit levels were comparable in patients both with and without atypical lymphocytes, and no statistically significant difference was seen ($p=0.197$).

Patient with unusual lymphocytes had markedly elevated liver enzyme levels. The SGPT levels exhibited a statistically significant difference ($p=0.044$), whereas the SGOT levels neared statistical significance ($p=0.078$). These data indicate that the presenceofatypicallymphocytesislinkedto moresevereliverinvolvementordamage inindividualswithdengue.Researchhasshow nthatdenguepatientsoftenhavehigher liver enzymes, which suggests that the liver is affected.

The mean hemoglobin level in NS1-positive patients was 12.08 g/dL, while the

mean erythrocyte mass in NS1-negative patients was 4.26 million cells/µL. NS1-positive patients had a higher mean total white blood cell count (12883.12 cells/µL) than NS1-negative patients (7786.96 cells/µL), although the difference was not significant at the 0.05 level.

InourstudytheNS1-positivepatientshadhigherhematocritlevels(mean37.85%)than NS1-negativepatients(mean34.25%).TheliverenzymesSGPTandSGOThadhigher mean values in NS1-positive patients than in NS1-negative patients, although these differences were not statistically significant.

In this study the IgM-negative patients had a mean hemoglobin level of 12.24 g/dL, compared to 11.06 in IgM-positive patients. The mean erythrocyte mass was significantlygreaterinIgM-negativepatients(mean4.62millioncells/µL) thaninIgM-positivepatients(4.19millioncells/µL). InpresentstudytheIgM-negativepatientshadahigherhematocrit(mean38.47%)than IgM-positive patients (mean 34.09%), p-value 0.004. IgM-negative individuals had higher liver enzyme levels (SGPT and SGOT), although the differences were not statistically significant.

IgG-negative patients had a mean hemoglobin level of 11.75 g/dL, compared to 12.79 in IgG-positive patients. Red blood cell mass was significantly greater in IgG-positive patients (mean 5.00 million cells/µL) compared to IgG-negative patients (4.42 million cells/µL). The mean corpuscular volume (MCV) and hemoglobin (MCH) of the two groups were identical, and the mean corpuscular hemoglobin concentration (MCHC) was also similar.

Conclusion

The increased positive rate of the NS1 antigen test indicates a wide spread acute stage of infection in patients.Hematologicresultsshowvariations inredandwhitebloodcellcounts,while biochemical data indicate the presence of liver complications in individuals with dengue fever. The presence of atypical lymphocytes is associated with marked hematologic and biochemical changes, including a decreased percentage of neutrophils and an increased percentage of lymphocytes, as well as elevated liver enzymes. These results emphasize the numerous physiological effects of dengue infection and the importance of atypical cells for the immune response.

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