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RESEARCH ARTICLE

Neutrophil to Lymphocyte Ratio as a new marker for predicting steatohepatitis in patients with Nonalcoholic Fatty Liver Disease

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Abbreviations: non alcoholic fatty liver disease (NAFLD), Neutrophil to Lymphocyte ratio (N/L),non alcoholic steatohepatitis (NASH) ,anti nuclear antibody (ANA), anti smooth muscle antibody (ASMA), anti mitochondrial antibody (AMA).

Abstract

Background: Nonalcoholic fatty liver disease is associated with a state of chronic inflammation, which may play a role in disease progression to non alcoholic steatohepatitis (NASH) and fibrosis. A liver biopsy remains the only method to distinguish NASH from simple steatosis.However, this is an invasive and expensive modality with serious potential complications and sampling errors .Therefore, the development of noninvasive markers that can identify patients with NASH greatly needed.

Objective: The aim of this study was to investigate the utility of neutrophil to lymphocyte (N/L) ratio as a simple, noninvasive and inexpensive new marker to predict the presence of NASH in patients with non alcoholic fatty liver disease (NAFLD) .

Study Design: This is an observational case-controlled study conducted in AL-Azhar University hospital . In our study, 90 individuals were selected and divided into three groups ; Group A (n=30) (NASH group) , Group B (n=30) (Simple steatosis) and Group C (n= 30) (healthy control group). All groups was subjected to the following , CBC with differential count and N/L ratio was calculated , Liver function tests , renal function tests , lipid profiles, C-reactive protein and abdominal ultrasound . Viral markers for HCV and HBV was measured in group A and group B only. Liver biopsy , Iron profiles (serum iron , transferrin saturation and serum Ferritin) and Autoimmune markers (ANA , ASMA , AMA) was performed in Group A only .

Results : Our results showed that there was highly statistically significant difference between patients groups (Aα,B) and control group(C) in relation to (N/L) ratio ($P<0.001$) and there was statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to (N/L) ratio ($P<0.001$) indicating that (N/L) ratio was significantly higher in NASH group in comparison to both simple steatosis and normal control groups and also(N/L) ratio was higher in the patients with simple steatosis group than the normal control group with the mean of (N/L) ratio in group A (2.19±0.609) , group B (1.55±0.36) and in group C (1.19±0.23). In our study the median of N/L ratio in patients with NASH was (2.19), which was significantly higher than in patients without NASH (1.55) and the Cut-off value of (1.63) has the highest sensitivity (76.7 %) and specificity (86.7 %) for detecting patients with NASH .

Conclusion : Neutrophil to Lymphocyte ratio can be used as a diagnostic noninvasive, a simple and inexpensive marker for detecting steatohepatitis in patients with NAFLD without the need for invasive liver biopsy and acut-off value of 1.63 can be used to identify patients with NASH.

INTRODUCTION

Nonalcoholic fatty liver disease (NAFLD) is the most common cause of abnormal liver function test results in both adults and children **(1).** NAFLD encompasses arange of conditions caused by fatty infiltration of the hepatocytes

without significant amounts of alcohol use **(2).** NAFLD begins with simple hepatocyte steatosis and progresses to non alcoholic steato hepatitis (NASH) ,fibrosis of the hepatocytes and liver cirrhosis, which can further progress to hepatocellular carcinoma (HCC) **(3).** Simple steatosis without fibrosis or inflammation has a benign clinical course in most but not in all cases without excess mortality**(4)** .NASH, on the other hand, may have a more progressive course that can lead to cirrhosis in 10-15% of patients. It is therefore imperative to distinguish simple steatosis from NASH in order to provide risk stratification and intervention slowing down disease progression **(5).** The presence of steatosis and inflammation with hepatocyte injury (ballooning) defines non-alcoholic steatohepatitis (NASH), which may or may not be accompanied by fibrosis **(6).** A liver biopsy remains the only method to distinguish NASH from simple steatosis and establish the extent of liver damage and fibrosis **(7).** However, this is an invasive and expensive modality with serious potential complications and sampling errors **(8).**Therefore, the development of noninvasive markers that can identify patients with NASH and significant fibrosis is greatly needed **(9).** Imaging studies such as ultrasonography, computed tomography (CT), and magnetic resonance imaging have been used to diagnose NAFLD. These modalities have the advantages of being noninvasive and can be repetitively performed over a period of time. Nevertheless, none of them have sufficient sensitivity and specificity for staging the disease and cannot distinguish between simple steatosis and NASH with or without fibrosis **(10).** Alanine aminotransferase (ALT) has been used as a surrogate marker for liver injury. Several studies suggested that ALT is not an ideal biomarker for either diagnosis of NAFLD or distinguishing simple steatosis from NASH **(11)** . Better noninvasive biomarkers or panels of biomarkers that are cheaper, reliable, and reproducible are urgently needed for patients with NASH to assist in establishing diagnosis, providing risk information, and monitoring disease progression and treatment response. Blood neutrophil to lymphocyte (N/L) ratio is a simple marker of subclinical inflammation that can be easily obtained from the differential white blood cell count. The N/L ratio has been used to predict outcomes in patients with cancer and coronary artery disease **(12).** A novel noninvasive marker of NAFLD severity has being identified. It involves measuring the blood neutrophil to lymphocyte (N/L) ratio. This ratio was found to be higher in patients with NASH than those with simple steatosis . The blood N/L ratio was shown to correlate with the main histologic features of NAFLD, including inflammation and fibrosis**(13).** This ratio integrates information on two different immune pathways – the neutrophils that are responsible for ongoing inflammation and the lymphocytes that represent the regulatory pathway, thus, the N/L ratio is an indicator of the overall inflammatory status of the body, and a higher ratio may be found in NAFLD patients with more advanced disease**(14).**

Subjects & Methods :

In our study, Nighty (90) individuals were selected from Outpatients clinic and Inpatients of internal medicine Department of El- Hussein university hospital, AL-Azhar University during the period from October 2014 to July 2015, and were divided into three groups.**Group A** (n=30) (NASH group), **Group B** (n=30) (Simple steatosis) and **Group C** (n= 30) (control group).**Group A** included 30 patients with clinical , ultrasonographic , laboratory(abnormal liver function tests) and histological evidence of steatohepatatis . Inclusion criteria of this group included; Clinical evidence of NAFLD (BMI >30 m^2 , WC > 102cm in male and >88cm in female and hepatomegally) , Ultra sound evidence of NAFLD and abnormal liver function tests specially elevated liver enzymes (AST, ALT and GGT) .Exclusion criteria of this group included; absence of alternate causes of elevated liver enzymes (Viral hepatitis , autoimmune hepatitis , metabolic causes like Wilson and hemochromatosis) , Drug induced hepatitis , History of alcoholic intake , History of Smoking (as smoking triggers an immune-inflammatory response and associated with increased levels of inflammatory markers). **Group B** included 30 patients with normal liver function tests but with clinical and ultrasound evidence of NAFLD and serve as simple steatosis group. inclusion criteria of this group included clinical evidence of NAFLD, US evidence of NAFLD, normal liver function tests, presence of risk factors for NAFLD (Hypertension,Hyperglycemia,Hypertriglyceridemia and Abdominal obesity). Exclusion criteria of this group included , Alcoholic intake , Elevated liver enymes (ALT,AST),history of Smoking. **Group C** included 30 patients with selction criteria of no clinical or US evidence of non-alcohol fatty liver disease, normal liver function tests, no evidence of metabolic syndrome, no history of alcoholic intake, No history of Smoking. All groups will be subjected to the following ; full history taking , full clinical examination, A complete blood count (CBC)with differential and The total white cell, neutrophil and lymphocyte counts were recorded, and the N/L ratio was calculated, Liver function tests (ALT, AST, serum bilirubin, serum Albumin, AST/ALT ratio, GGT and alkaline phosphatase), Lipid profiles (Total cholesterol, LDL-cholesterol, HDL-cholesterol and Triglycerides), Fasting blood sugar(FBS), Inflammatory markers (CRP) , Renal function tests (BUN, creatinine) and Abdominal Ultra sound . Group A and B was subjected to viral markers for HCV and HBV. Group A only was subjected to investigations to rule out other causes of abnormal liver function tests; iron profiles including (serum iron , transferrin saturation and serum Ferritin),Autoimmune markers (ANA , ASMA , AMA). Liver biopsy was performed to Group A only and liver histology was assessed by an experienced hepato-pathologist blinded to the patients, clinical and laboratory data.

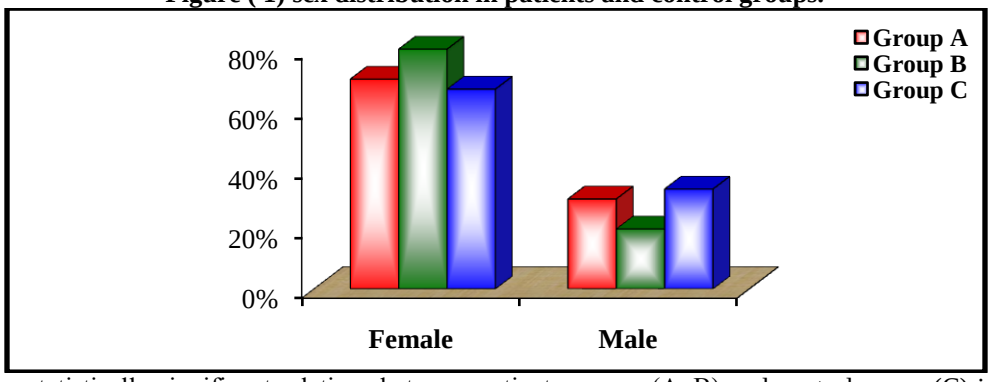
Statistical methodology:

Data was analyzed on an IBM personal computer using statistical package for science(SPSS) software computer program version 18. Description of all data in the form mean (M) and standard deviation (SD) for all quantitative variables was done. Frequency and percentage for all qualitative variables was calculated .comparison between quantitative variables was done using t-test to compare two groups and ANOVA(analysis of variance) to compare more than two groups.comparison of qualitative variables was done using chi-square test.Correlation coefficient also was done to find linear relation between different variables using r-test or sperman correlation coefficient. Significant level measured according to P value (propability), P>0.05 is insignificant , and P<0.05 is significant.

Results:

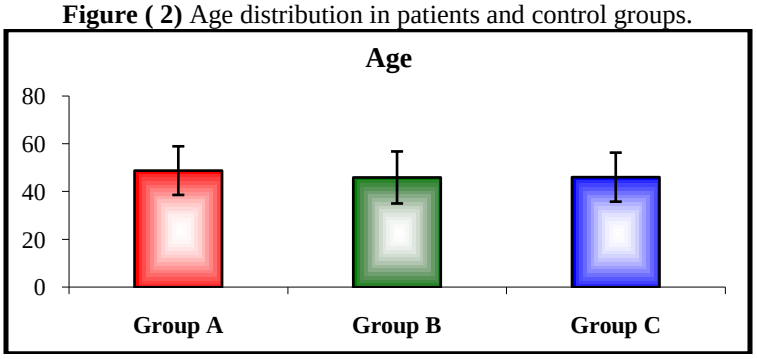
the present study included 90 cases divided into three groups ; **Group A** (n=30) were patients with steatohepatitis 21 female (70 %) and 9 male (30%) , **Group B** (n=30) were patients with simple steatosis 24 female (80 %) and 6 male (20%) and **Group C** (n=30) were normal control group **(Fig 1)** . the age ranged from 18 to 68 years **(Fig 2) .** Our study showed that there was statistically significant difference between patients groups (AαB) and control group(C) in relation to body weight (p=0.011) while there was no statistically significant difference between group A(NASH) and group B (Simple steatosis) in relation to body weight (p=0.242) . also our study showed that there was statistically significant difference between patients groups (Aα,B)and control group(C)in relation to Waist Circumference (WC) (P =0.001) while there was no statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to WC (p=0.411) . also our results showed that there was statistically significant difference between patients groups (AαB) and control group(C) in relation to BMI (P=0.004) while there was no statistically significant difference between group A (NASH group) and group B (Simple steatosis) in relation to BMI (P=0.476) **.** As regard to liver enzymes the present study demonstrated that there was highly statistically significant difference between patients groups (Aα,B)and control group(C) in relation to ALT , AST and GGT levels with p value (0.001, 0.001, 0.001) respectively and also there was statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to ALT, AST and GGT levels with p value (0.001 ,0.001, 0.001) respectively. **(Table 1) , (Table 2)** . As regard to lipid profile the present study demonstrated that there were no statistically significant relations between patients groups (AαB)and control group(C) in relation to serum triglyceride (P = 0.797) but there was highly statistically significant difference between patients groups (Aα,B)and control group(C), in relation to serum cholesterol level (P =0.012). As regard to inflammatory markers , our results revealed that there was highly statistically significant difference between patients groups (Aα,B) and control group(C), in relation to C_reactive protein (CRP) level (P = 0.001) and there was statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to CRP level (P = 0.001) **(Table 3) (Fig 3).** Our results showed that there was highly statistically significant difference between patients groups (Aα,B)and control group(C) in relation to Neutrophil to Lymphocyte ratio (N/L) (P =0.001) and there was statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to(N/L) ratio (P= 0.001) indicating that (N/L) ratio was significantly higher in NASH group in comparison to simple steatosis group and normal control group with the mean of Neutrophil to Lymphocyte ratio (N/L) in group A (2.19±0.609),group B (1.55±0.36) and in group C (1.19±0.23). And so (N/L) ratio was significantly higher in NASH group in comparison to simple steatosis group and also higher in the patients with simple steatosis than the normal control group. **(Table 4).** The cut-off value of N/Lratio between patients and controls in our study was > 1.35 with sensitivity 86.7 % and specificity 80.0% **(Table 5) (Fig 4)** while the cut-off value of N/Lratio between NAFLD and NASH was ≥1.63 with sensitivity 76.7 % and specificity 86.7%.**(Table 6) (Fig 5).**

Figure (1) sex distribution in patients and control groups.



There was no statistically significant relations between patients groups (AαB) and control group (C) in relation to sex.

Figure (2) Age distribution in patients and control groups.



There was no statistically significant relations between patients groups (AαB) and control group (C) in relation to age.

Table (1) ALT distribution in patients and control groups.

	ALT		ANOVA	
	Range	Mean ± SD	F	P-value
Group A	38.00 - 132.00	58.600 ± 20.900	89.754	<0.001*
Group B	7.00 - 31.00	17.900 ± 5.454		
Group C	11.00 - 33.00	21.233 ± 6.745		
Tukey's test				
A&B	**A&C**	**B&C**		
<0.001*	<0.001*	0.586		

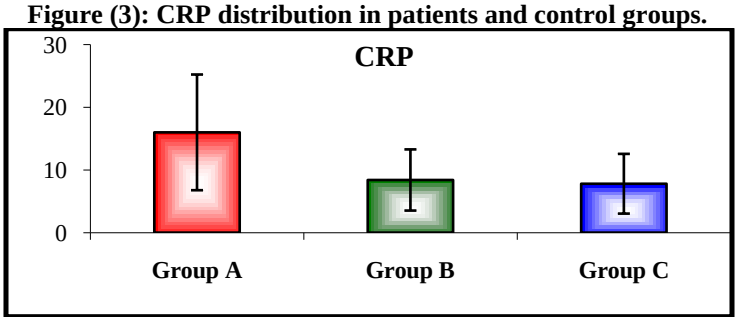
There was highly statistically significant difference between patients groups (Aα,B)and control group(C)in relation to ALT level and there was statistically significant difference between group A and group B in relation to ALT level.

Table (2) GGT distribution in patients and control groups.

	GGT		ANOVA	
	Range	Mean ± SD	F	P-value
Group A	33.00 - 98.00	60.333 ± 15.517	17.063	<0.001*
Group B	13.00 - 75.00	40.500 ± 15.186		
Group C	18.00 - 72.00	41.767 ± 13.374		
Tukey's test				
A&B	**A&C**	**B&C**		
<0.001*	<0.001*	0.941		

There was statistically significant relations between patient group A and groups (Bα C) in relation to GGT level, and there was statistically significant difference between group A and group B in relation to GGT level .

Figure (3): CRP distribution in patients and control groups.



(Table 3) CRP distribution in patients and control groups.

	CRP		ANOVA	
	Range	Mean ± SD	F	P-value
Group A	6.00 - 48.00	16.000 ± 9.233	14.268	<0.001*
Group B	6.00 - 24.00	8.400 ± 4.882		
Group C	6.00 - 24.00	7.800 ± 4.766		
Tukey's test				
A&B	**A&C**	**B&C**		
<0.001*	<0.001*	0.935		

There were statistically significant relations between patients group A and other groups (Bα C) in relation to CRP level and there were statistically significant difference between group A and group B in relation to CRP level .

Table(4): Neutrophil to Lymphocyte ratio distribution in patients and control groups.

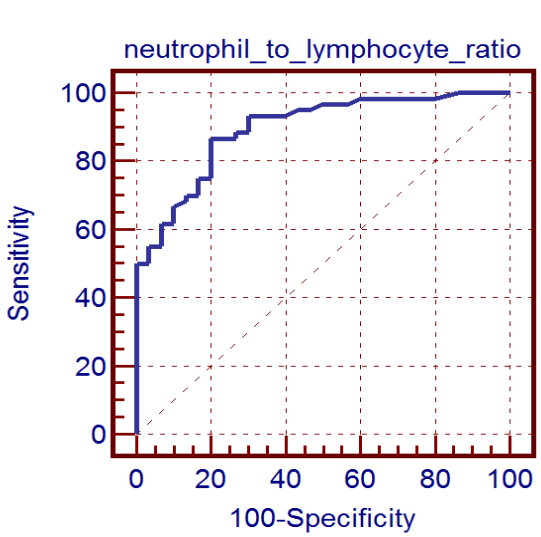
	N/L		ANOVA	
	Range	Mean ± SD	F	P-value
Group A	1.38 - 3.80	2.195 ± 0.609	41.616	<0.001*
Group B	1.00 - 2.50	1.558 ± 0.361		
Group C	0.75 - 1.74	1.193 ± 0.235		
Tukey's test				
A&B	**A&C**	**B&C**		
<0.001*	<0.001*	0.004*		

There was highly statistically significant difference between patients groups (Aα,B) and control group (C) in relation to (N/L) ratio (p <0.001) and there was statistically significant difference between group A(NASH group)and group B(Simple steatosis) in relation to (N/L)ratio p <0.001.

Table (5) cutoff value for N/L ratio between patients and controls

ROC curve between patients and controls as regard N/L ratio					
Cutoff	Sens.	Spec.	PPV	NPV	Accuracy
> 1.35	86.7	80.0	89.7	75.0	89.5

Figure (4) cutoff value for N/L ratio between patients and controls



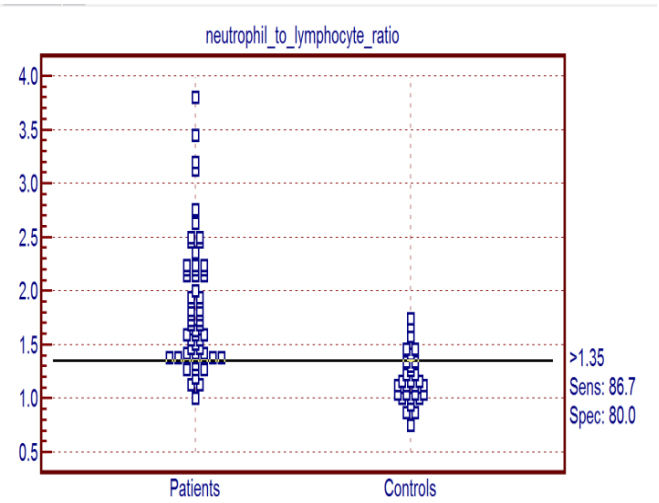
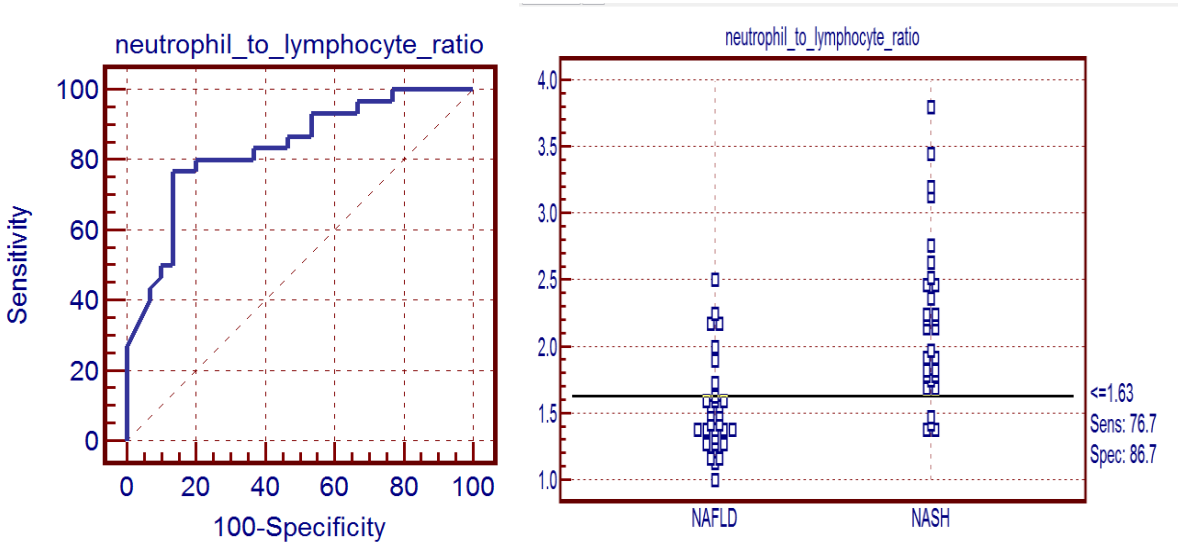


Table (6) cutoff value for N/L ratio between NAFLD and NASH

ROC curve between NAFLD and NASH as regard N/L ratio					
Cutoff	**Sens.**	**Spec.**	**PPV**	**NPV**	**Accuracy**
≥ 1.63	76.7	86.7	85.2	78.8	83.4

Figure (5) cutoff value for N/L ratio between NAFLD and NASH



Discussion :

Our results showed that there were no statistically significant difference between the three groups in relation to age distribution (p =0.490) with the mean age for group A (48.83 ±10.18), group B (45.96±10.89) and group C (46.1±10.26) . Also Our study showed that there were no statistically significant relations between patients groups (A,B)and control group(C) in relation to the sex distribution (P= 0.476). In this study there was statistically significant difference between patients groups (AαB) and control group(C) in relation to body weight (p=0.011) while there was no statistically significant difference between group A(NASH) and group B (Simple steatosis) in relation to body weight (p=0.242) indicating that both NASH group and Simple steatosis group had increased body weight in comparison to normal control group ,with the mean body weight in group A (88.8±11.66) , group B (83.8±13.12) and in group C (76.3±10.59) . Also our results demonstrated that there was statistically significant difference between patients groups (AαB) and control group(C) in relation to BMI (p=0.004)) while there was no statistically significant difference between group A(NASH group) and group B (Simple steatosis)in relation to BMI (P =0.476) indicating that both NASH group and Simple steatosis group had increased BMI in comparison to normal control group ,with the mean BMI in group A (33.45±4.57), group B (31.09±5.17) and in group C was (27.52±3.64). In Our study we included 90 individuals divided into 3 groups (each of which =30) in group (A) 20 patients had the criteria of metabolic syndrome and in group (B) 20 patients had the criteria of metabolic syndrome indicating strong correlation between fatty liver and metabolic syndrome. Our results was consistent with the results of **Rius et al ., 2012,** who found that the BMI were significantly higher in patients with NAFLD (n=250) in comparison to control group (n= 240) **(15).** These results were opposite to the results of **Wong et al ., 2015,** who stated that a body weight within normal limits does not provide any guarantee of keeping free of NAFLD **(16).** our study showed also that there was statistically significant difference between patients groups (Aα,B)and control group(C)in relation to Waist Circumference (WC) (P =0.001) while there was no statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to WC (p=0.411) indicating that both NASH group and Simple steatosis group had increased WC in comparison to normal control group with the mean WC in group A (102.5±9.96), group B (99.86±9.76) and group C (93.63±6.5).These results was compatible with **Lin et al ., 2010,** who stated that the measurement of WC is better than BMI to predict liver steatosis and is considered as a substitute of central obesity assessment **(17).** As regard to liver enzymes our results showed that there was highly statistically significant difference between patients groups (Aα,B)and control group(C)in relation

to ALT level (p<0.001) and there was statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to ALT level value (p<0.001) indicating that ALT level was significantly higher in NASH group in comparison to simple steatosis group and normal control group, with the mean in group A (58.6±20.9) , group B (17.9±4.45) and in group C(21.23±6.74) . Also there was highly statistically significant difference between patients groups (A,B)and control group(C), in relation to AST level (p<0.001) and there was statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to AST level (p<0.001) indicating that AST level was significantly higher in NASH group in comparison to simple steatosis group and normal control group with the mean in group A (59.56±24.36) , group B (21.4±5.76) and in group C (22.7±5.92) . Also there was highly statistically significant difference between patients groups (A,B)and control group(C), in relation to GGT level (p<0.001) and there was statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to GGT level (p<0.001) indicating that GGT level was significantly higher in NASH group in comparison to simple steatosis group and normal control group with the mean in group A(60.33±15.61) , group B (40.50±15.18) and in group C (41.76±13.37) . These results demonstrated that NASH group had higher liver enzymes (ALT,AST,GGT) in comparison to Simple steatosis and normal control group and may be used as indicator of NASH in patients with NAFLD. Our results were parallel to the results obtained by **Tahan et al ., 2008 ,** who showed that increased GGT level was a risk factor for advanced fibrosis in NAFLD, **(18).** Our results was in contrast to the results of **Mofrad et al ., 2003** who reported that the entire histological spectrum of NAFLD could be seen in individuals with normal ALT values. The histological spectrum of NAFLD in people with NAFLD and elevated ALT was not significantly different from those with NAFLD without elevated ALT. alow normal ALT dese not gurantee freedom from underlying NASHwith advanced fibrosis **(19)** . As regard to lipid profile the present study showed that there were no statistically significant relations between patients groups (AαB)and control group(C) in relation to serum triglyceride (P =0.797) but there was highly statistically significant difference between patients groups (Aα,B)and control group(C), in relation to serum cholesterol (P= 0.012) indicating that both NASH group and Simple steatosis group had increased serum cholesterol in comparison to normal control group,with the mean of serum cholesterol level in group A (213.4±34.63) , group B (202.6±47.18) and in group C (161.3±44.24). also there was highly statistically significant relations between patients groups (Aα,B)and control group(C) in relation to low density lipoprotein (LDL) (P <0.001) with the mean of low density lipoprotein (LDL) level in group A (100.6±33.49), group B (95.6±31.42) and in group C (74.06±16.21) . As regard to inflammatory markers , our results revealed that there was highly statistically significant difference between patients groups (Aα,B) and control group(C), in relation to C_reactive protein (CRP) (P <0.001) and there was statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to CRP level (P <0.001) indicating that CRP level was significantly higher in NASH group in comparison to simple steatosis group and normal control group. And so our study demonstrated high significance of CRP for prediction of steatohepatitis and it was higher in patients group A(NASH group) with the mean (16±9.23)than that of the patients group B (NAFLD) with the mean (8.40±4.88) Pvalue was (0.001), so we can use this marker as anon invasive tool for detection of steatohepatitis in patients with hepaticsteatosis. The same results obtained by **Yoneda et al ., 2007**, who stated that (Hs-CRP) was measured in 100 patients with histologically verified NAFLD (29 with steatosis and 71 with NASH), the results revealed that hs-CRP was significantly elevated (P = 0.0048) in cases of NASH in comparison with cases of steatosis,Also Yonedaetal 2007 demonstrated consistent and profound elevation of hs-CRP in cases of NASH compared with in cases of simple non progressive steatosis, results suggested that hs-CRP may be a clinical feature that not only distinguishes NASH from simple nonprogressivesteatosis but also indicates the severity of hepatic fibrosis in cases of NASH**.(20).** As regard to neutrophil to lymphocyte ratio Our results revealed that there was highly statistically significant difference between patients groups (Aα,B)and control group (C) in relation to Neutrophil to Lymphocyte ratio (N/L) (p <0.001) and there was statistically significant difference between group A(NASH group) and group B(Simple steatosis) in relation to (N/L) ratio (p <0.001) indicating that (N/L) ratio was significantly higher in NASH group in comparison to simple steatosis group and normal control group with the mean of Neutrophil to Lymphocyte ratio (N/L) in group A (2.19±0.609),group B (1.55±0.36) and in group C (1.19±0.23). And so (N/L) ratio was significantly higher in NASH group in comparison to simple steatosis group and also higher in the patients with simple steatosis than the normal control group.In our study the median of N/L ratio in patients with NASH was 2.19, which was significantly higher than the N/L ratio in patients without NASH 1.55 and the Cutoff of Neutrophil to Lymphocyte ratio (N/L) was 1.63 with sensitivity 76.7 % and specificity 86.7 %. Accordingly the (N/L) ratio can be used as a diagnostic noninvasive marker for detecting steatohepatitis in patients with NAFLD without the need for invasive liver biopsy and also it is a simple, inexpensive test that can be obtained from CBC. Our results was compatible with **Alkhouri etal.,2012**. Who reported that the median N/L ratio in patients with NASH was 2.5 (Q25–Q75 = 1.9, 3.3), which was significantly higher than the N/L ratio in patients without NASH 1.6 (Q25- Q75 = 1.2, 2.0) (P value<

0.001), the ROC analysis suggested that a cut-off value of 1.9 has the highest sensitivity (72%) and specificity (70%) for detecting patients with NASH **(21).**

In another study who assess (N/L) ratio and CRP and there association with liver histology in patients with NASH , chronic hepatitis B , and hepatitis C . 38 consecutive patients with biopsy proven NASH was enrolled , 19 patients with HCV, 45 patients with HBV and 35 healthy controls who were similar for age and gender, (N/L) ratio was significantly higher in NASH patients compared to controls, HBVand HCV patients (P <0.001, P <0.001, P <0.001 respectively) and concluded that (N/L) ratio is a promising and inexpensive inflammation marker that correlates with histological grade and fibrosis stage in NASH patients. **(22).**The opposite results were obtained by **Kara etal., 2015** who included 226 consecutive patients with biopsy proven NAFLD (NASH,N=105),borderline NASH (n=74),and simple steatosis (47) were enrolled.Significant differences were found in AST(P<0.001),ALT(P<0.001)levels and white blood cell(P=0.007) and neutrophil counts (P=0.042) between the three groups of patients. the findings of the present study showed that NLR is not associated with the severity of hepatic inflammation or fibrosis and thus cannot be recommended as a surrogate marker of liver injury in patients with NAFLD.**(23).**

Conclusion :

Neutrophil to Lymphocyte ratio can be used as a diagnostic noninvasive, a simple and inexpensive marker for detecting steatohepatitis in patients with NAFLD without the need for invasive liver biopsy and acut-off value of 1.63 can be used to identify patients with NASH.

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