**Oxidised low-density lipoprotein (oxLDL) as a biomarker for non-alcoholic fatty liver disease (NAFLD)**

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**Abstract**---Background and Aim: NAFLD is a condition that is increasing dramatically in incidence and prevalence globally. There is known to be a direct relationship between conventional risk factors of metabolic syndrome and NAFLD. However, it is not a compulsion that these names risk factors will always be seen; it is, therefore, necessary to find investigations that could serve as predictive screening tests to catch the development of NAFLD in an individual at its earlier stages. OxLDL is a product of oxidative stress, and the circulating levels of the molecule seem to have possible risk predictor capability. With very little research previously conducted, the aim of the current study is to determine if there is a relationship between OxLDL and NAFLD. The study is limited to the Indian population.  
Method: A case-control study was conducted in a tertiary care teaching hospital; a total of 50 individuals were tested for circulating OxLDL levels. Of the tested subjects, 25 were patients with various stages of nonalcoholic liver disease, and 25 made up a control group of no liver pathology. Fasting blood samples were taken from all test subjects, and the serum underwent enzyme immunoassay to determine the OxLDL levels.  
Results: In this study, there was a slight male predominance (60%) over females (40%). In the experimental group comprising of 25 cases of NAFLD at various grading, 12 patients also had type 2 diabetes mellitus (48%). 7 patients (28%) had hypertension. OxLDL levels were found to be significantly higher in the experimental group versus the
control group during this study (1.5025 ± 0.0167 in experimental and 1.2918 ± 0.193 in the control). Conclusion: The present study shows an elevation of circulation OxLDL in the blood of patients with NAFLD. The relationship between OxLDL levels and progression of NAFLD was very significant, and therefore should be further investigated in a population with a larger sample size to help prove the significance of oxidative stress as a risk factor for NAFLD. This can lead to earlier detection of the disease and prevent its consequences.

**Keywords**—NAFLD, metabolic syndrome, OxLDL.

**Introduction**

Nonalcoholic fatty liver disease is amongst the most common conditions in the country, with more than 10 million cases being newly diagnosed every year in accordance with a census conducted by Apollo Hospitals in India. Diverse manifestations have been described in all ethnicities across the world, with evidence estimating a growing trend in prevalence for the next decade [1,6]. NAFLD frequently precipitates into chronic liver failure and must be treated with transplantation in severe cases -- a common occurrence in Western countries. However, increasing numbers of studies have pointed towards an uptrend in Asian countries over the past few years as well [3]. For these reasons, it is logical to predict a similar progression in India, despite the limited data presently available. NAFLD is just as likely to be of equal severity in Asian populations and in Western populations, but the associated metabolic pandemics have been seen to occur more in the Asian demographic as of recent times, in comparison to the United States or Europe [4]. Prevalence in Asian countries ranges between 15-45%, versus 30% in the United States [4,7]. The global prevalence of NAFLD was estimated to be at 24% in the year 2017. Its highest numbers were found to be from South America and the Middle East, followed by Asia, the US, and Europe, respectively [8].

In a review of clinical literature over the past 30 years, it was found that “The prevalence of NAFLD is highest amongst the populations with pre-existing metabolic conditions” (Vernon et al). Due to changes in lifestyle and diet throughout the global population, numbers of individuals with metabolic conditions have drastically increased -- especially in the adolescent age group. Those who are overweight from childhood itself are at a much greater risk for developing dyslipidemias and NAFLD. Therefore, the stages of morbidity or mortality due to liver disease would appear at younger ages. In a population of adolescents, the suspected prevalence of NAFLD increased from 3.9% between the years of 1988 and 1994 to 10.7% in 2007-2010, with increases across all ethnic subgroups, gender, and those obese [8,9]. NAFLD patients were also found to more likely to be male, in the older age group, and hypertensive [5,7,10].

Diagnosis of NAFLD and nonalcoholic steatohepatitis (NASH, a more severe form of NAFLD) can be done in many ways. Bedside ultrasound is a non-invasive method of diagnosing liver pathology. Determining the severity of hepatic steatosis in the presence of metabolic syndrome is better done by the ultrasound than
screening for elevated liver enzymes [11]. Normal levels of alanine aminotransferase do not effectively rule out significant conditions of NASH [12]. However, elevated aspartate aminotransferase in relation to ALT has been associated with the later stages of steatosis [13]. It remains that a liver biopsy is the gold standard diagnostic tool, due to the higher sensitivity and specificity of histopathology compared to the biochemical markers. Thus, the tests for liver enzymes and ultrasound remain as screening modalities.

Nonalcoholic fatty liver disease is a condition of fat accumulation in the liver in the absence of excessive alcohol consumption [18]. The etiology has not been entirely confirmed, but there is a strong association between nonalcoholic liver pathology and metabolic syndrome. Metabolic syndrome consists of a few conditions, namely obesity, type 2 diabetes, and dyslipidemia. [5,7,19,20,21]. A number of secondary causes may also be involved, including the metabolic conditions of abetalipoproteinemia or lipodystrophy, or drug-induced in cases of use of glucocorticoids, methotrexate, chemotherapy, etc. Other causes could be inflammatory bowel disease or occupational exposure [1,2,19].

“The condition is characterized by triglyceride and free cholesterol accumulation without a corresponding increment in cholesterol esters” [22]. The liver is a major site for lipid metabolism and plays an important role in the regulation of energy metabolism as well. Phytosterol and dietary cholesterol are managed in the GI tract and ultimately processed in the liver. Many studies have shown that altered liver cholesterol homeostasis and free cholesterol are directly related to the pathogenesis of NAFLD and its progression. Cholesterol has been found to be a critical nutritional factor for NASH in animal models and human test subjects [24,25,30,31]. Perhaps due to this accumulation and concentration of cholesterol in vessels to and of the liver, the condition has been associated with cardiovascular and liver-related mortality [22].

Oxidative stress is defined as a disturbance in the balance between the production of reactive oxygen species and antioxidant defenses [33]. This imbalance leads to potential damage to tissue and molecular structures, namely cholesterol. Oxidative stress has been implicated as an aggregator of NAFLD and may directly affect its progression into NASH. Oxidized lipid products have been shown to be associated with the disease state over many studies [32]. Among these lipid products is oxidized low-density lipoprotein (OxLDL). Previous studies have shown OxLDL to contribute to plaque formation in the walls of major vessels. Thus, OxLDL has been found as a cause for atherosclerosis, and its presence in larger quantities as a risk factor for metabolic disease [54,56,59]. It has been noted that circulating levels of OxLDL are significantly increased in patients with cardiac disease, and there was also a slight difference between control individuals with diabetes mellitus and those without [55].

Although the risk factors of obesity, hyperlipidemia, and diabetes have been found to have a direct effect on NAFLD and related pathologies, the disease is heading towards numbers indicating increased prevalence in the coming years [7,9]. Therefore, it is necessary to find molecular risk factors and develop an understanding of the complete etiopathogenesis of the condition in order to prevent a global epidemic. Although OxLDL has been described numerous times
to be associated with atherosclerosis, there is very limited data showing its link to NAFLD. The increasing incidence of NAFLD in the younger population makes it imperative that precautions be taken to prevent the progression of damage done by oxidative stress to liver pathology. Further studies are needed to determine a direct relationship between OxLDL and NAFLD; this study aims to observe the incidence of nonalcoholic liver pathology and corresponding levels of OxLDL in the blood.

Aims and Objectives

1. To assess the levels of oxLDL in individuals diagnosed with NAFLD in a South Indian tertiary care center
2. To assess the levels of oxLDL in a sample of normal individuals in the same South Indian population
3. To compare levels of oxLDL in normal individuals versus individuals with NAFLD
4. To study the correlation between the levels of circulating oxLDL and incidence of NAFLD
5. To correlate the levels of circulating of oxLDL and other risk factors

Materials and Methods

This was a case-control study conducted between July and October 2019. It took place at a tertiary care center in South India, at a teaching hospital. The study population consisted of individuals who presented to a Master Health Checkup under the department of General Medicine; patients who were retrospectively diagnosed with nonalcoholic fatty liver disease who came for a routine checkup.

Sample Size:
A total of 50 patients (25 patients with NAFLD, 25 control participants) were asked to voluntarily enter the study. The sample size was determined by SPSS software using previous literature [62]. Patient history and general examination were taken to determine the history of liver pathology as well as metabolic conditions. Control participants were taken to match experimental groups in the factors of age and sex.

Data was collected for measuring the levels of circulating oxidized low-density lipoprotein. Conditions and details of liver pathology were taken through the use of bedside ultrasonography techniques. Liver function tests and lipid profile measures were previously conducted to ensure the presence of NAFLD in the patient, and determine the severity of the pathology. Anthropometric details such as BMI were also collected. Patients were asked in detail about their history of diabetes, hypertension, and dyslipidemias.

Institutional Ethics Committee approved the study; clearance was obtained. Strict maintenance of patients’ confidentiality in terms of names and personal details was ensured. Written informed consent was obtained from all study participants.

Selection Criteria:
Inclusion Criteria (of Experimental Group) -
Patients who came to Master Health Checkup with the previously diagnosed nonalcoholic fatty liver disease through ultrasonography were included in the study. Patients should not have been frequent alcohol consumers.

Exclusion Criteria (of Experimental Group) -
Individuals with alcoholic tendencies were not tested. Those who have had a history of cardiovascular disease, namely coronary artery disease and myocardial infarction, were not included. Patients who had undergone liver transplantation surgery or any cardiac surgery within the past three months were also excluded.

Inclusion Criteria (of Control Group) -
Patients who were admitted for different pathology in the General Medicine wards as well those who came into Master Health Checkup were asked to participate in the study. The control group included stable patients who did not have a history of frequent alcohol consumption.

Exclusion Criteria (of Control Group) -
Individuals with a history of fatty liver disease were not considered. This included NAFLD, AFLD, hepatitis, or simple hepatomegaly. Patients of cardiovascular disease or myocardial infarction were also not considered. Patients taking drugs affecting the liver in any way, namely hepatotoxic drugs, were not considered. This also excluded patients undergoing any other treatments that could affect their liver in any way.

Sample Collection

Under aseptic conditions, 4 mL of blood was drawn from the median cubital vein of the test subject into a plain vacutainer with no anticoagulant. The venous blood sample was taken after a 12 hour fast. Plasma samples were collected by centrifugation, within 2 hours of collection. They were then transferred to Eppendorf tubes and stored. Samples were stored at 4 degrees Celsius for a maximum period of 2 weeks before undergoing ELISA testing.

Test - Enzyme Immunoassay of Oxidised Low-Density Lipoprotein

Method - Sandwich ELISA procedure
OxLDL was measured by an enzyme immunoassay. The OxLDL in plasma was measured by Sandwich ELISA using anti-OxLDL monoclonal antibodies. The plasma samples were diluted as per the instructions of the kit. The plate was coated with the capture antibody, the samples were added and any binding between antigen and antibody occurred. A detecting antibody was then added, and then an enzyme-linked secondary antibody was added. This binds to detecting antibody. Finally, a substrate was added and it was converted into a form of electrochemical signal which can be read for quantitative measurement based on its absorbance.

Diagnosis of NAFLD and NASH

The experimental group recruited for this study underwent bedside ultrasonography as an outpatient procedure to confirm the presence of fatty liver disease. They were then graded based on the USG findings. Patients in this study were either of fatty liver grade 1, 2, or 3.
**Statistical Analysis**

The data entry and subsequent analysis of the data were meticulously carried out as per standard protocol. The analysis was performed with SPSS software. Results were presented as the mean of the values and their standard deviation. The unpaired t-test was used for the analysis between experimental and control groups. The groups were then analyzed by ANOVA, with data presented as a mean value and its standard error. A P value of <0.05 was considered to be statistically significant. For all calculations, the confidence of the standard 95% was used.

**Observations and Results**

In this case-control study carried out in a tertiary care teaching hospital, a total of 50 individuals were tested for circulating OxLDL levels. Of the tested subjects, 25 were patients with various stages of nonalcoholic liver disease, and 25 made up a control group of no liver pathology. Of the Experimental Group, ultrasonography was used to determine that 7 individuals (28%) had grade 1 fatty liver, 16 individuals (64%) had grade 2, and 2 individuals (8%) had grade 3. Within the Experimental Group, 10 patients (40%) were female and 15 patients (60%) were male. The mean BMI of the NAFLD patients was 26.101 ± 1.56. In the Control Group, subjects were matched to age and sex. Hence, 10 individuals were female and 15 were male. The mean BMI of the Control Group was 24.2101 ±1.41.

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Grade of NAFLD</th>
<th>Number of Patients</th>
<th>Mean OxLDL Levels - Concentration</th>
<th>Mean OxLDL Levels (U/L)</th>
<th>Number of Patients with DM</th>
<th>Number of Patients with HTN</th>
<th>Mean Patient BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Grade 1</td>
<td>7</td>
<td>2,831.278 ±285.124 (±10.07%)</td>
<td>1.3193 ±0.119 (±9.01%)</td>
<td>2</td>
<td>0</td>
<td>28.1429 ±3.223</td>
</tr>
<tr>
<td>2.</td>
<td>Grade 2</td>
<td>16</td>
<td>3,335.1075 ±173.606 (±5.21%)</td>
<td>1.5077 ±0.0831 (±5.51%)</td>
<td>8</td>
<td>6</td>
<td>26.8875 ±0.953</td>
</tr>
<tr>
<td>3.</td>
<td>Grade 3</td>
<td>2</td>
<td>3,846.875 ±427.289 (±11.11%)</td>
<td>1.6805 ±0.282 (±16.78%)</td>
<td>2</td>
<td>1</td>
<td>24.8 ±0.97</td>
</tr>
</tbody>
</table>

Table 1 summarises the data obtained from the experimental group. All values were taken and averaged. The mean of the OxLDL levels is expressed in Units/Litre. There is a significant difference between grade 1 and grade 2 levels (P=0.00420). There is also a significant difference between grade 2 and grade 3 (where P=0.04648), but it is of less significance than the difference between grade 1 and 2.
Table 2: Summary of Control Group Data

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Sub-Group</th>
<th>Number of Patients</th>
<th>Mean OxLDL Levels - Concentration</th>
<th>Mean OxLDL Levels (U/L)</th>
<th>Mean Patient BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control with T2DM</td>
<td>11</td>
<td>3,104.5273 ±180.631 (±5.82%)</td>
<td>1.4308 ±0.0734 (±5.13%)</td>
<td>25.2273 ±1.539</td>
</tr>
<tr>
<td>2</td>
<td>Control without T2DM</td>
<td>14</td>
<td>2,481.405 ±66.278 (±2.67%)</td>
<td>1.1526 ±0.0273 (±2.37%)</td>
<td>23.1929 ±1.191  (±5.14%)</td>
</tr>
</tbody>
</table>

Table 2 summarises the data obtained from the control group. The mean value of OxLDL levels is presented in U/L. Individuals with T2DM and those without were assessed separately. There is a difference of high significance between the two groups (with P= 0.001476).

![Fig 1: Stage of NAFLD vs. Quantity of OxLDL](image)

**Key:**
1. Grade 1 NAFLD
2. Grade 2 NAFLD
3. Grade 3 NAFLD
4. Control with T2DM
5. Control without T2DM
Figure 1 is a bar graph that visually depicts the mean OxLDL values of each subgroup. Stage 1 NAFLD patients had levels of 1.3193 U/L, Stage 2 patients had 1.5077 U/L, Stage 3 had 1.6805 U/L. Normal controls with T2DM had levels of 1.4308 U/L, and controls without a history of T2DM had an average of 1.1526 U/L. We can see that the lowest average levels belong to those individuals who do not have liver pathology or any diabetic history. Diabetic patients have higher average levels of OxLDL than those with grade 1 NAFLD.

### Two-Sample Independent t Test

<table>
<thead>
<tr>
<th>Two-sided confidence interval</th>
<th>95%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group-1</strong></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>25</td>
</tr>
<tr>
<td>Mean</td>
<td>1.5025</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.167</td>
</tr>
<tr>
<td>Std. Error</td>
<td>0.193</td>
</tr>
<tr>
<td><strong>Group-2</strong></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>25</td>
</tr>
<tr>
<td>Mean</td>
<td>1.2918</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.193</td>
</tr>
</tbody>
</table>

**Result**

<table>
<thead>
<tr>
<th>Equal variance</th>
<th>t statistics</th>
<th>df</th>
<th>p-value</th>
<th>Mean Difference</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.12779</td>
<td>48</td>
<td></td>
<td>0.0001451</td>
<td>0.2107</td>
<td>0.108068</td>
<td>0.313332</td>
</tr>
<tr>
<td>Unequal variance</td>
<td>4.12779</td>
<td>47</td>
<td>0.0001487</td>
<td>0.2107</td>
<td>0.108012</td>
<td>0.313388</td>
</tr>
</tbody>
</table>

**Fig 2: t-Test: Experimental Group vs. Control Group**

Figure 2 is a table showing the relationship between the two values of OxLDL levels: the experimental group and the control group, without any further subgrouping. The P-value is calculated and depicts values of a very high significant difference, suggesting a correlation between liver pathology and OxLDL levels.

### Analysis of Variance (ANOVA)

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of squares</th>
<th>d.f</th>
<th>Mean square</th>
<th>F statistics</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1.21636</td>
<td>4</td>
<td>0.304089</td>
<td>41.2619</td>
<td>0.00000000000000016463</td>
</tr>
<tr>
<td>Within Groups</td>
<td>0.331639</td>
<td>45</td>
<td>0.00736974</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.548</td>
<td>49</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test for equality of variance</th>
<th>Chi square</th>
<th>d.f</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24.7377</td>
<td>4</td>
<td>0.0000568039</td>
</tr>
</tbody>
</table>

**95% CI of individual sample mean**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.3193</td>
<td>1.20924</td>
<td>1.42936</td>
</tr>
<tr>
<td>2</td>
<td>1.5077</td>
<td>1.46342</td>
<td>1.55198</td>
</tr>
<tr>
<td>3</td>
<td>1.6805</td>
<td>-0.853232</td>
<td>4.21423</td>
</tr>
<tr>
<td>4</td>
<td>1.4308</td>
<td>1.38149</td>
<td>1.48011</td>
</tr>
<tr>
<td>5</td>
<td>1.1526</td>
<td>1.13684</td>
<td>1.16836</td>
</tr>
</tbody>
</table>

**95% CI assuming equal variance**

<table>
<thead>
<tr>
<th>Group</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2399</td>
<td>1.3987</td>
</tr>
<tr>
<td>2</td>
<td>1.46196</td>
<td>1.55344</td>
</tr>
<tr>
<td>3</td>
<td>0.909174</td>
<td>2.45183</td>
</tr>
<tr>
<td>4</td>
<td>1.37313</td>
<td>1.48847</td>
</tr>
<tr>
<td>5</td>
<td>1.10303</td>
<td>1.20217</td>
</tr>
</tbody>
</table>

Key:
Figure 3: ANOVA Test - All Subgroups as Variables

Figure 3 is an image showing the ANOVA statistical method. It is used to test differences between two or more means. Inferences about the mean values can be made by analyzing the variance. It generates a t-test beyond two groups and therefore can calculate a P-value that is valid over all 5 subgroups. The results show very high significance (with P=0.0000568) over the five subgroups.

Discussion

The present case-control study investigated a total of 50 patients in a South Indian tertiary care teaching hospital to study OxLDL as a biochemical risk factor for NAFLD. To our knowledge, a similar study has not yet been conducted within this ethnic group.

Circulating OxLDL levels were measured in patients who presented to the hospital for a Master Health Checkup. The presence of NAFLD and its grading was done based on bedside ultrasonography. In our study, there was a slight male predominance (60% of the patients were male, and 40% were female). In the experimental group comprising of 25 cases of NAFLD at various grading, 12 patients also had type 2 diabetes mellitus (48%). 7 patients (28%) had hypertension.

OxLDL levels were found to be significantly higher in the experimental group versus the control group during this study (1.5025 ± 0.0167 in experimental and 1.2918 ± 0.193 in the control). The findings are similar to that of the study conducted by Ozturk et al in which they found higher levels of OxLDL in patients with NAFLD than normal patients, and also a significant difference between levels in accordance with the grade of NAFLD. Similarly, our data show significant elevation between stage 1 NAFLD patients, who had the mean OxLDL levels of 1.3193 ±0.119 and stage 2 NAFLD, who had levels of 1.5077 ±0.0831. Showing a similar trend, levels further increased to 1.6805 ±0.282 in patients with grade 3 fatty liver. Both the present study and the one conducted by Ozturk et al can conclude that the levels of OxLDL could be used to differentiate between normal and affected patients, while also differentiating between simple NAFLD and progressed steatohepatitis.

However, in the study conducted by Ozturk et al, the experimental group consisted of a greater number of patients with NASH, or stage 3 fatty liver (34% of subjects). Therefore, there would have been a higher OxLDL level seen in the overall experimental group versus the normal control subjects. Furthermore, the study was conducted in Turkey, ethnic backgrounds may affect results in the predisposition of individuals to oxidative stress, for example. Since there are

| 1. Grade 1 NAFLD    | 2. Grade 2 NAFLD    | 3. Grade 3 NAFLD    | 4. Control with T2DM | 5. Control without T2DM |
limited studies in relation to the correlation between the two factors, the background cannot be entirely disregarded. Also, the study mentioned did not include patients with diabetes mellitus in the control group, so the results between the present study and the one by Ozturk et al cannot be directly compared.

The present study showed a positive correlation between NAFLD and OxLDL levels overall. However, the levels of OxLDL in control subjects with T2DM had a mean of $1.4308 \pm 0.0734$. In comparison, the patients with grade 1 NAFLD only had an average level of $1.3193 \pm 0.119$. These two conditions, when isolated, refute the hypothesis that NAFLD and OxLDL are directly related even in the presence of other metabolic conditions. Although not significant, the levels are higher in those with T2DM than those with stage 1 fatty liver. These results were not seen in any previous studies [62,63]. Therefore, a larger-scale study must be conducted to establish a relationship.

There was a wide range in the age of the study population in the present study. The ages of individuals in the experimental group began at 22 years of age at the lower end and extended to 80 years. If the study were to be reconducted for further investigative purposes, the population should be restricted to a younger age group to reduce the number of external factors that may affect the dependent variable. However, age did not seem to play a role in the levels of OxLDL in this particular study.

There is an uptrend in NAFLD incidence worldwide, with more and more adolescents becoming prone to the condition. For this reason, there is a need for a predictive factor that can serve as a screening test or diagnostic tool to identify those at risk. From the findings of this study, it can be inferred that OxLDL plays a vital role in the progression of NAFLD.

**Conclusion**

OxLDL promises to be a reliable predictor for identifying liver pathology in the studied population. This study supports the hypothesis that OxLDL can be noted as a biochemical risk factor for NAFLD and its progression into NASH. Other studies have also been suggestive of a similar conclusion [62, 63]. Our study shows a positive correlation between OxLDL and nonalcoholic liver damage. We are led to believe that the molecule can therefore be used as a potential biomarker for identifying the presence of the disease and its further development into stage 2 fatty liver or NASH.

Previous studies are few in number but have also shown there to be a direct relationship between the two variables. The present study was limited in sample size, further investigation with a larger population should be conducted before the test can be implemented in routine. However, since our study also found a significant increase in OxLDL levels in patients with type 2 diabetes mellitus, but without liver pathology, it can question the specificity of the test. Therefore, more studies with a design to study the sensitivity and specificity of OxLDL as a biomarker must be conducted.
NAFLD is on the verge of becoming a global epidemic in the upcoming years. It can easily progress into a condition precipitating morbidity and mortality, and it is, therefore, imperative to detect the condition at its earlier stages. However, early identification of NAFLD proves to be a challenge, despite being an easily preventable disease.

Implications

Currently, liver biopsy and imaging studies are the diagnostic approaches to determining the severity of the liver disease. If oxLDL levels prove to consistently be raised in individuals suffering from the disease, diagnostics will become easier: the patient will experience less discomfort as compared to liver biopsy, costs will be reduced, and the patient may be more cooperative. Furthermore, deeming oxLDL to be a biomarker for the fatty liver can facilitate the understanding of the pathogenesis, and increase the efficiency of drug development: we can refine clinical data, and create speedy access to safer drugs.

Since OxLDL is a direct product of oxidative stress, and accumulation of the molecule would suggest its involvement in the pathogenesis, leading us to believe that treating the oxidative stress could prevent conditions such as NAFLD. This could promote research into the levels of antioxidants in the blood and propose an inverse relationship between antioxidants and nonalcoholic liver pathology. Furthermore, antioxidants can be introduced as a treatment option to prevent the progression of the disease.

References

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