Original Article

Study on NAFLD and Liver Stiffness in Type 2 Diabetes Patients with Normal BMI

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Abstract

Background : With increasing incidences of NAFLD in both obese and non obese individuals it is very important to correlate the incidence of NAFLD in Type 2 Diabetes mellitus with normal weight. Although there are multiple studies where liver stiffness has been studied using conventional elastographic techniques studies correlating liver stiffness with non invasive markers of fibrosis are lacking.

Aims and Objective : To assess the prevalence of Non-alcoholic Fatty Liver Disease (NAFLD) and liver stiffness in Type 2 Diabetes Mellitus (T2DM) patients with normal Body Mass Index (BMI) and explore the relationship between liver stiffness and non-invasive markers of liver fibrosis.

Materials and Methods : A cross-sectional study was conducted from January, 2023 to July, 2024 at Tripura Medical College and Dr BRAM Teaching Hospital, including 100 T2DM patients with normal BMI. Liver stiffness and fat content were measured using Fibroscan. Non-invasive markers APRI and FIB-4 scores were used to predict fibrosis severity. Data were analysed using SPSS 26.0.

Results : Among the 100 patients, 63% were diagnosed with NAFLD, with a slightly higher prevalence in females. The prevalence of liver fibrosis was 65%, with higher rates in females. Positive correlations were found between liver stiffness and non-invasive markers: APRI (r=0.507, p<0.0001) and FIB-4 (r=0.443, p<0.0001).

Conclusion : There is a significant prevalence of NAFLD and liver fibrosis among T2DM patients with normal BMI. Regular screening and early intervention are crucial for preventing progression to severe liver conditions.

Key words : Type 2 DM, NAFLD, Liver Stiffness.

Non-alcoholic Fatty Liver Disease (NAFLD) may be defined as excessive fat accumulation in the liver with ≥5% of hepatocytes containing visible intracellular triglycerides or steatosis affecting at least 5% of the liver volume or weight in patients without any history of significant alcohol consumption (20 gm in women and 30g in men daily)[1]. NAFLD encompasses a spectrum of liver conditions ranging from simple steatosis (known as Non-alcoholic Fatty Liver or NAFL), to Non-alcoholic Steatohepatitis (NASH) characterized by histologically evident ballooning degeneration of hepatocytes and hepatocellular injury, which can then progress to fibrosis, cirrhosis, and hepatocellular carcinoma[2,3]. While NAFLD is commonly associated with obesity, emerging evidence suggests that it can also occur in individuals with normal Body Mass Index (BMI), especially those with metabolic conditions like T2DM in whom, it is increasingly now recognized as a significant public health issue. In fact, epidemiological studies suggest that, in general up to 10-20% of individuals diagnosed with NAFLD could be lean.[4] Infact, individuals with lean NAFLD have been found to have an increased risk of developing Type 2 Diabetes mellitus (T2DM) and exhibit higher all-cause mortality compared to their obese counterparts with NAFLD[2,5,6].

Editor's Comment :

- In Type 2 Diabetes Mellitus patients with normal BMI ie, those without obesity, NAFLD (63%) and liver fibrosis (65%) are common.
- Non-invasive markers like APRI & FIB 4 show strong positive correlation with liver stiffness measured by Fibroscan. Hence it supports the utility of these markers. Therefore, regular screening & early intervention are essential in Type 2 Diabetes Mellitus population to prevent progression to advanced liver disease irrespective of body weight.

The prevalence of NAFLD among T2DM patients with normal BMI is not well-documented, particularly in the Indian population. Understanding the burden of NAFLD in this subgroup is crucial for developing targeted screening and management strategies. Additionally, liver stiffness, a key indicator of liver fibrosis, can be non-invasively measured using transient elastography (Fibroscan). Non-invasive markers such as the Aspartate Aminotransferase-to-Platelet-Ratio Index (APRI) and the FIB-4 score are valuable tools for assessing liver fibrosis risk and severity[7-11].

This study was conducted to assess the prevalence of Non-alcoholic Fatty Liver Disease (NAFLD) and liver stiffness in patients with Type 2 Diabetes Mellitus (T2DM) who have a normal Body Mass Index (BMI) and attend Tripura Medical College and Dr BRAM Teaching Hospital. The objectives were to determine the prevalence of NAFLD among T2DM patients with normal BMI, evaluate liver stiffness using

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Fibroscan technology, and explore the relationship between liver stiffness and non-invasive markers of liver fibrosis, such as the APRI (Aspartate Aminotransferase-to-Platelet-Ratio Index) and the FIB-4 score (a fibrosis index based on age, AST, ALT, and Platelet count).

This hospital-based cross-sectional study was conducted in the Department of Medicine at Tripura Medical College and Dr BRAM Teaching Hospital, Hapania, West Tripura, over one and a half years from January, 2023 to July, 2024. The study population included T2DM patients with a normal BMI attending the Department of Medicine. Inclusion criteria were adults aged 18 years and older with T2DM for more than five years and a normal BMI (18.5-24.9) as per WHO guidelines. Exclusion criteria included patients with pre-existing Acute or Chronic Liver Disease, heart failure or other causes of congestive hepatomegaly, rib cage deformities preventing the use of Fibroscan, pregnant women, unwilling participants, and those with an implantable defibrillator or Pacemaker.

The sample size was calculated to be 100 using a non-probability (convenient) sampling method. Data was collected using a semi-structured proforma to gather detailed medical history, anthropometric measurements, and biochemical investigations. Liver fat and stiffness measurements were performed using Fibroscan, with APRI and FIB-4 scores derived from observed values. Transient elastography (Fibroscan) was used to measure liver stiffness and fat content, with liver stiffness results categorized as F0 to F4 based on kilopascals (kPa), and liver fat content assessed using the Controlled Attenuation Parameter (CAP).

Operational details included calculating BMI by dividing weight in kilograms by height in meters squared. Liver stiffness was measured using Fibroscan, with normal results between 2 and 7 kPa. Results were categorized from F0 (1-6 kPa) to F4 (≥10.4 kPa). CAP was measured in decibels per meter (dB/m) to assess liver fat content, with categories from S0 (no steatosis) to S3 (severe steatosis). APRI was calculated using AST level and platelet count to predict fibrosis severity, and FIB-4 was an index using age, AST, ALT and Platelet count to assess liver fibrosis risk.

Data was entered into MS Excel and analyzed using SPSS 26.0, with statistical tests such as the chi-square test, t-test and Pearson correlation applied at a significance level of $p<0.05$. Ethical approval was obtained from the Institutional Ethical Committee, and informed consent was obtained from all participants, ensuring confidentiality and adherence to ethical guidelines.

Results

The study included 100 diabetic patients with normal BMI, with an average age of 55.6 years (±9.9years). The age range was between 32 and 84 years. The majority of participants (68%) were between 51-75 years, and the gender distribution was 61% male and 39% female.

Among the 100 participants, 63% were diagnosed with NAFLD using Fibroscan.

The prevalence of NAFLD was slightly higher in females (64.1%) than in males (62.3%), but this difference was not statistically significant (p-value >0.05).

The highest prevalence of NAFLD was observed in the 51-75 years age group

The grades of fatty liver showed that a significant number of patients are in the advanced stages of the disease, with Grade III being the most prevalent (36.5%), followed by Grade II (33.3%) and Grade I (30.2%).

The prevalence of liver fibrosis in the study population was 65%. Similar to NAFLD, liver fibrosis was more common in females (71.8%) than in males (60.7%), although this difference was not statistically significant (p-value=0.265). The majority of fibrosis cases were found in the 51-75 years age group, with no fibrosis observed in patients younger than 35 years.

The most common stage of fibrosis was Stage 2 (33.8%), followed by Stage 1 (29.2%) and Stage 4 (26.2%). The presence of significant fibrosis in a large proportion of patients highlights the importance of early detection and intervention to prevent progression to cirrhosis or liver failure.

The APRI and FIB-4 scores were used to assess fibrosis severity and risk. Most participants had moderate to significant fibrosis based on APRI and FIB-4 scores,with a substantial proportion at moderate risk according to the FIB-4 score. Specifically, the APRI score indicated that 66% of participants had moderate or significant fibrosis, while the FIB-4 score showed that 56% were at moderate risk.

There was a positive correlation between liver stiffness and non-invasive markers of liver fibrosis:

- **APRI and Liver Stiffness :** Pearson correlation coefficient (r) = 0.507, p-value <0.0001, indicating a strong positive correlation.
- **FIB-4 and Liver Stiffness :** Pearson correlation coefficient (r)=0.443, p-value<0.0001, also indicating a significant positive correlation.

Discussion

The study indicates a significant burden of liver disease among diabetic patients with normal BMI. Dash, *et al* reported the overall NAFLD prevalence of 54% in Type 2 Diabetes Mellitus patients by random effects models with variations across different populations[12]. Although it did not specifically involve those with normal BMI.

The study highlights the need for targeted screening and

management strategies for middle-aged and older adults with Diabetes.

A significant number of patients are in the advanced stages of the disease. Tsai, *et al* in their study found that patients with T2DM are more likely to have advanced liver disease, with more than 50% (83/163) of the subjects having moderate to severe NAFLD13.

It was seen that age is a significant factor in the development of fibrosis among diabetic patients.

The presence of significant fibrosis in a large proportion of patients highlights the importance of early detection and intervention to prevent progression to cirrhosis or liver failure.

There was a positive correlation between liver stiffness and non-invasive markers of liver fibrosis: however, APRI picked up significant fibrosis with higher sensitivity than FIB 4.

The score relations suggest that non-invasive markers like APRI and FIB-4 scores can be effective in assessing liver stiffness and fibrosis risk in diabetic patients (Figs 1&2).

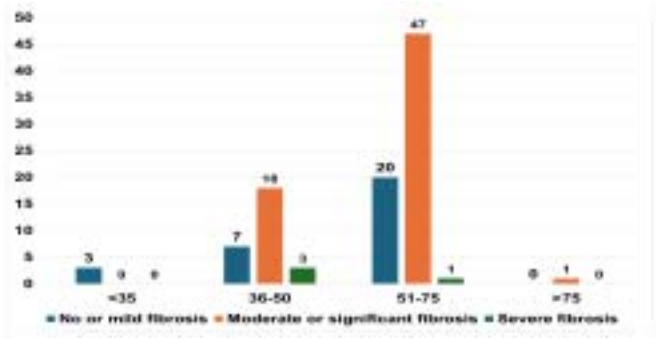

Fig 1 — Fibrosis by APRI across age groups

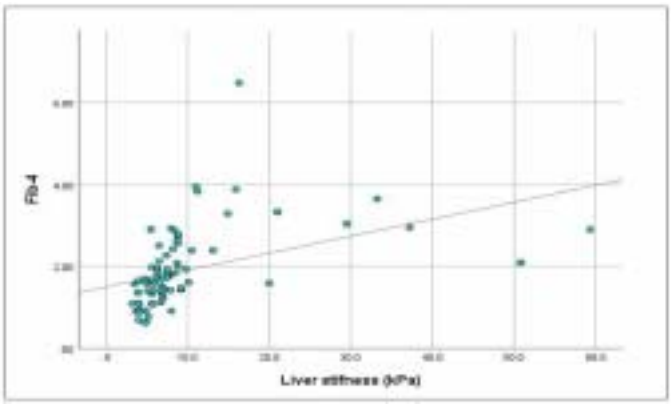

Fig 2 — Correlation between Fib-4 and Liver Stiffness

Conclusion

The study concludes that there is a significant prevalence of NAFLD and liver fibrosis among diabetic patients with normal BMI. Despite gender differences being statistically insignificant, there was a slightly higher prevalence in females. The findings emphasize the importance of regular screening and early intervention to prevent progression to severe liver conditions. This study, being the first of its kind in northeast India, particularly in Tripura, suggests the need for further research with larger and more diverse samples to validate these findings.

The study underscores the need for comprehensive management strategies focusing on liver health in diabetic patients, regardless of their BMI. Regular screening, early detection and appropriate interventions are crucial to prevent the progression of NAFLD and liver fibrosis to more severe liver conditions such as cirrhosis and liver failure. Overall, this study highlights the importance of addressing liver health in diabetic patients and provides valuable insights for clinical practice and future research.

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Conflict of Interest : None.

References

1 Hashimoto E, Taniai M, Tokushige K — Characteristics and diagnosis of NAFLD/NASH. *J Gastroenterol Hepatol* 2013; **28 Suppl 4:** 64-70.
2 Younossi Z, Anstee QM, Marietti M, Hardy T, Henry L, Eslam M, *et al* — Global burden of NAFLD and NASH: trends, predictions, risk factors and prevention. *Nat Rev Gastroenterol Hepatol* 2018; **15(1):** 11-20.
3 Kuchay MS, Choudhary NS, Mishra SK — Pathophysiological mechanisms underlying MAFLD. *Diabetes Metab Syndr* 2020; **14(6):** 1875-87.
4 Vilarinho S, Ajmera V, Zheng M, Loomba R — Emerging role of genomic analysis in clinical evaluation of lean individuals with NAFLD. *Hepatol Baltim Md* 2021; **74(4):** 2241-50.
5 Younossi ZM, Stepanova M, Negro F, Hallaji S, Younossi Y, Lam B, *et al* — Nonalcoholic fatty liver disease in lean individuals in the United States. *Medicine (Baltimore)* 2012; **91(6):** 319-27.
6 Younes R, Bugianesi E — NASH in Lean Individuals. *Semin Liver Dis* 2019; **39(1):** 86-95.
7 Shili-Masmoudi S, Wong GLH, Hiriart JB, Liu K, Chermak F, Shu SST, *et al* — Liver stiffness measurement predicts long-term survival and complications in non-alcoholic fatty liver disease. *Liver Int Off J Int Assoc Study Liver* 2020; **40(3):** 581-9.
8 Cassinotto C, Boursier J, de Lédinghen V, Lebigot J, Lapuyade B, Cales P, *et al* — Liver stiffness in nonalcoholic fatty liver disease: A comparison of supersonic shear imaging, FibroScan, and ARFI with liver biopsy. *Hepatol Baltim Md* 2016; **63(6):** 1817-27.
9 Yoneda M, Fujita K, Inamori M, Nakajima A, Yoneda M, Tamano M, *et al* — Transient elastography in patients with non alcoholic fatty liver disease (NAFLD). *Gut* 2007; **56(9):** 1330-1.
10 Costa-Silva L, Ferolla SM, Lima AS, Vidigal PVT, Ferrari TC de A — MR elastography is effective for the non-invasive evaluation of fibrosis and necroinflammatory activity in patients with nonalcoholic fatty liver disease. *Eur J Radiol* 2018; **98:** 82-9.
11 Boursier J, Vergniol J, Guillet A, Hiriart JB, Lannes A, Le Bail B, *et al* — Diagnostic accuracy and prognostic significance of blood fibrosis tests and liver stiffness measurement by FibroScan in non-alcoholic fatty liver disease. *J Hepatol* 2016; **65(3):** 570-8.
12 Amiri Dash Atan N, Koushki M, Motedayen M, Dousti M, Sayehmiri F, Vafaee R, *et al* — Type 2 diabetes mellitus and non-alcoholic fatty liver disease: a systematic review and meta-analysis. *Gastroenterol Hepatol Bed Bench* 2017; **10(Suppl1):** S1–7.
13 Tsai HJ, Tsai YC, Hung WW, Hung WC, Chang CC, Dai CY — Gut Microbiota and Non-Alcoholic Fatty Liver Disease Severity in Type 2 Diabetes Patients. *J Pers Med [Internet]* 2021 Mar [cited 2024 Jul 15]; **11(3)**. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8004607/