International Journal of Research in Medical Sciences
Khan SS et al. Int J Res Med Sci. 2017 Jan;5(1):225-230
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20164554

Original Research Article

Association of non-alcoholic fatty liver disease with anthropometric and metabolic parameters in type 2 diabetes: a retrospective analysis

Shiraz S. Khan[1]*, Nishad S. Kannu[2], Sagar S. Patil[1], Vijay M. Katekhaye[3]

[1]Department of Gastroenterology, Amrita school of Medicine, Kochi, Kerala, India
[2]Esskay's Centre for Internal Medicine and Diabetes, Attingal, Kerala, India
[3]Dev clinic, Ayachit Mandir road, Mahal, Nagpur, Maharashtra, India

Received: 02 November 2016
Accepted: 01 December 2016

***Correspondence:**
Dr. Shiraz S. Khan,
E-mail: drshiraskhan@yahoo.co.in

ABSTRACT

Background: Type 2 diabetes (T2D) is associated with increased prevalence of non-alcoholic fatty liver disease (NAFLD) which mediates increased insulin resistance and is associated with cardiovascular disease (CVD) risk factors. Aim of the study was to understand the association of NAFLD with anthropometric and metabolic parameters in T2DM.
Methods: A retrospective observation of data obtained from a private diabetes care centre in non-alcoholic T2D patients was performed. Association of presence of NAFLD with anthropometric, metabolic (glycemic, lipid) parameters, and also blood pressure were assessed. Patients were duly informed that the data collected pertaining to their illness could be used for research purposes. No changes or interventions in the management of the illness were made as part of this study.
Results: In total, 300 cases were included in analysis. NAFLD was seen in 38.0% of the cases. Patients with fatty liver were much older than those without fatty liver ($P<0.0001$). A significant association of NAFLD was seen with all anthropometric ($P<0.05$ for each) and lipid ($p<0.05$ for each) parameters and also systolic and diastolic blood pressure measurements ($p<0.0001$ for both). There was no significant association with glycemic levels in patients with NAFLD. Other factors which had significant association with fatty liver include duration of diabetes, duration of hypertension and a known history of hypertension and dyslipidaemia ($p<0.0001$ for each).
Conclusions: NAFLD has significant association with cardio-metabolic risk factors and may be an independent risk factor for CV disease. Further prospective studies with effect of diabetes treatment and progression/regression of NAFLD and its association with CV outcomes in T2D are warranted.

Keywords: Blood pressure, BMI, Lipids, NAFLD, Type 2 Diabetes, Weight

INTRODUCTION

Non-alcoholic fatty liver disease (NAFLD) is found to have association with insulin resistance which is seen patients of T2D, obesity and dyslipidaemia.[1] Type 2 diabetes (T2D) is a globally evolving epidemic and there is a significant contribution to the global burden of T2D from India.[2] The prevalence of NAFLD varies from 30 to 60% and it tends to increase with increase in obesity.[3] A large nationwide cohort study from India reported NAFLD prevalence to be 56.5% in patients with T2D.[4]

Pathophysiologically, it is not only steatosis but also involves hepatic cellular injury and is associated with inflammatory changes. NAFLD is said to be representative of hepatic manifestation in metabolic syndrome (MS).[3] Imbalance of adipocytokines and proinflammatory cytokines tend to increase the severity

of NAFLD in T2D and further accelerate the progression to non-alcoholic steatohepatitis and cirrhosis.[5]

NAFLD is the most frequent etiology for abnormal liver function tests (LFTs) in patients with T2D.[6] A suspicion should be raised with mild elevation of aminotransferase in T2D. Finding NAFLD is essential as it represents insulin resistance. Given its association with increasing obesity, insulin resistance and T2D, NAFLD is considered as a risk factor for cardiovascular disease (CVD). Inflammation, oxidative stress, obesity, insulin resistance, endothelial dysfunction, imbalance of adipocytokines and proinflammatory cytokines are the major linkages associating NAFLD as factor for increased CVD risk.[7] From among various modalities of screening NAFLD, ultrasonography (US) offers safe, accessible, affordable and radiation-free method of providing enough assessment details for NAFLD diagnosis and staging. With a sensitivity of 60 to 94% and specificity of 84 to 95%, US is helpful for effective screening.[8] With this background, we evaluated patients with T2D for NAFLD and studied its association with anthropometric and metabolic parameters.

METHODS

Observational analysis of database performed a retrospective, observational assessment of a database of a private, urban, diabetes care centre over last 3 years between June 2013 and August 2016 to identify potential patients for inclusion in to the study. We included adult patients aged above 18 years, non-alcoholic patients with type 2 diabetes who had undergone abdominal ultrasound examination for any reason. Fatty liver was identified by an expert sonologist in all patients included in present study. Fatty liver if noted was reported and was labelled as mild, moderate or severe as per standard radiological parameters.

As a part of treatment plan, these patients had anthropometric and metabolic assessments done and their data was captured in a database. We included only those patients having all the assessments details available from database. We excluded pregnant and lactating females, renal dysfunction or haemodialysis cases, patients with diagnosed cancer receiving chemotherapy, patients receiving drugs with potential hepatotoxicity as per available literature were excluded. Alcoholics, and those with previous history of significant liver disease or any current illness resulting in acute hepatic injury were excluded.

Assessments that were performed in patients are described in brief below. We noted demographic details like age, gender, along with clinical history and duration of diabetes, hypertension, and dyslipidemia were noted. Anthropometric assessments noted were weight (kg), height (m), body-mass index (BMI, Kg/m^2), waist and hip circumference (cm), and waist: hip circumference ratio (WHR). Glycaemic assessments included glycosylated haemoglobin A1c (HbA1c%), fasting blood glucose (FBG, mg/dL) and post-prandial blood glucose (PPBG mg/dL). Latest reports in database were considered for analysis. Patients who had HbA1c of 7% and above were labelled as uncontrolled diabetes. Levels of systolic and diastolic blood pressures (BP, mmHg) were considered. Patients with systolic BP of 140 mmHg or more and diastolic BP of 90 or more were considered as hypertensive.

Lipid assessments (normal values) included total cholesterol (<200 mg/dL), triglycerides (<150 mg/dL), low-density lipoprotein cholesterol (LCL-C, <100 mg/dL), high-density lipoprotein cholesterol (HDL-C, >40 mg/dL in males and >50 mg/dL in females), along with very-low density lipoprotein (VLDL <30 mg/dL), and non-HDL-C (<130 mg/dL). The institutional ethical committee had approved the study.

Statistical analysis

Data were presented as means (SD) for continuous variables and as frequency (%) for categorical variables. Independent sample t test for continuous and Chi square test for categorical variables were used tests for assessing significance in patients with and without fatty liver. P value < 0.05 was considered significant.

RESULTS

From total of 300 cases, fatty liver on ultrasound was evident in 38.0% patients (Figure 1).

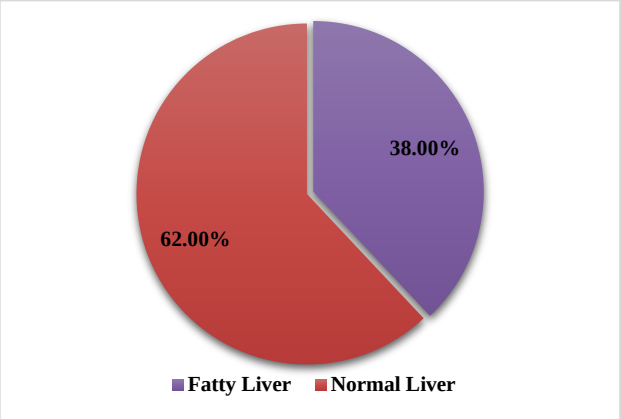

Figure 1: Detection rate of fatty liver on ultrasound.

Mean age of the population was 54.6 years and 24.7% of the study populations were above 65 years of age. Males (61.7%) were more frequent than females (38.3%). Nearly, one-fourth (22.3%) were current smokers. 36.7% were recently diagnosed with diabetes whereas rest were known cases with mean duration of 11.1 years.

Hypertension (44.7%) and dyslipidemia (34.7%) were frequent comorbidities in present study population. Baseline characteristics of the patients are summarized in

Table 1. Comparative evaluation of demographic, anthropometric and metabolic parameters in patients with and without fatty liver is presented in Table 2.

Among demographic parameters, mean age was significantly higher in patients with fatty liver than those with normal liver (60.5±9.9 Vs 50.9±10.8 respectively, p<0.0001). Elderly population more frequently were encountered with fatty liver (42.1% vs 14.0%, p<0.0001), but its occurrence did not differ among males and females (p=0.074).

Table 1: Baseline characteristics of patient population.

Characteristics	Observation
Age	54.6±11.4
Age range	26 to 80
Age > 65 years	74 (24.7)
Sex	
Male	185 (61.7)
Female	115 (38.3)
Current Smoking	67 (22.3)
Diabetes status	
New (<3 months)	110 (36.7)
Old (>3 months)	190 (63.3)
Diabetes duration in old cases (years)	11.1±7.5
Known Hypertension	134 (44.7)
Hypertension Duration (years)	9.9±7.2
Known Dyslipidemia	104 (34.7)

Data presented as mean±SD and frequency (%)

Higher proportion of smokers were found to have fatty liver (29.8% Vs 17.7%, p=0.015). Compared to those without fatty liver, means of all anthropometric parameters namely weight, BMI, waist circumference and waist: hip ratio were significantly higher in patients with fatty liver (p<0.0001 for all comparisons).

We assessed metabolic profile on three co-morbidities namely diabetic, hypertensive and lipid parameters. Mean duration of diabetes was also significantly greater in patients with fatty liver (14.3±7.2 vs 8.2±6.5, p<0.0001). However, measures of glycaemia including HbA1c (p=0.375), FBG (p=0.239) and PPBG (p=0.716) were not different in two groups (Table 2).

Compared to patients without fatty liver, significant higher values were seen for the presence of hypertension, mean duration of hypertension, mean systolic and diastolic blood pressure in patients having fatty liver (p<0.0001 for all comparisons) (Table 2).

Significantly higher proportion of patients with fatty liver had presence of dyslipidemia (54.4% Vs 22.6, p<0.0001). Mean levels of the lipid panel parameters namely total cholesterol (p<0.0001), triglycerides (p<0.0001), VLDL (p<0.0001) and LDL (p<0.0001) were significantly higher in fatty liver group whereas mean HDL was significantly lower (p=0.042) in these patients (Table 2).

Table 2: Demographic, anthropometric and metabolic profile in patients with and without fatty liver.

Characteristics	Fatty Liver on USG		P value
	Present (n=114)	Absent (n=186)	
Demographic			
Age	60.5±9.9	50.9±10.8	<0.0001
Age > 65 years	48 (42.1)	26 (14.0)	<0.0001
Male Sex	63 (55.3)	51 (44.7)	0.074
Current Smoking	34 (29.8)	33 (17.7)	0.015
Anthropometric			
Weight	68.1±13.3	57.1±10.0	<0.0001
BMI	27.0±5.2	21.5±3.5	<0.0001
Waist circumference (cm)	98.5±11.5	88.4±9.4	<0.0001
Waist: hip ratio	0.92±0.07	0.88±0.05	<0.0001
Metabolic			
Diabetic profile			
Known diabetes	90 (78.9)	100 (53.8)	<0.0001
Diabetes duration (years)	14.3±7.2	8.2±6.5	<0.0001
HbA1c (%)	8.4±1.7	8.6±1.9	0.375
Fasting blood glucose (mg/dL)	188.6±91.6	202.0±98.2	0.239
Post-meal blood glucose (mg/dL)	244.3±79.3	241.0±74.4	0.716
Hypertension Profile			
Known Hypertension	77 (67.5)	57 (30.6)	<0.0001
Hypertension Duration (years)	7.8±8.4	2.3±4.7	<0.0001
Current Systolic BP (mmHg)	140.4±29.0	127.2±23.2	<0.0001
Current Diastolic BP (mmHg)	90.8±20.8	81.8±17.3	<0.0001
Lipid Profile			
Known Dyslipidemia	62 (54.4)	42 (22.6)	<0.0001
Total cholesterol (mg/dL)	181.4±51.2	158.5±43.1	<0.0001
Triglycerides (mg/dL)	156.4±62.5	118.3±36.7	<0.0001
Very low density lipoprotein (mg/dL)	31.3±12.5	23.7±7.4	<0.0001
Low density lipoprotein (mg/dL)	120.3±27.8	106.3±25.7	<0.0001
High density lipoprotein (mg/dL)	42.4±6.4	43.9±6.5	0.042
Non-High density lipoprotein (mg/dL)	139.0±53.1	114.6±44.7	<0.0001

Data presented as mean±SD and frequency (%), Independent sample t test for continuous variables, Chi-square test for categorical variables. P<0.05 significant.

Table 3 shows the association of control of metabolic parameters with presence of fatty liver. Glycemic control defined by HbA1c < 7% was not significantly different in

patients with and without fatty liver (p=0.075) and majority of diabetes on treatment were not controlled (83.0%) to desired HbA1c goal. Interestingly, systolic BP to goal of <140 mmHg was observed in significantly lower proportion of fatty liver patients (39.5% Vs 65.6%, p<0.0001). Among lipid parameters, significantly higher proportion of patients with fatty liver had raised total serum cholesterol levels (28.1% Vs 9.1%, p<0.0001), raised serum TGs (45.6% Vs 17.7%, p<0.0001), raised serum LDL-C (71.1% Vs 57.5%, p=0.019).

Table 3: Fatty liver association with control of glycaemic, blood pressure andlipid parameters.

Characteristics	Total	Fatty Liver on USG		P value
		Present (n=114)	Absent (n=186)	
HbA1c (%)				
< 7	51 (17.0)	25 (21.9)	26 (14.0)	0.075
≥ 7	249 (83.0)	89 (78.1)	160 (86.0)	
Systolic BP (mmHg)				
< 140	167 (55.7)	45 (39.5)	122 (65.6)	<0.0001
≥ 140	133 (44.3)	69 (60.5)	64 (34.4)	
Total cholesterol (mg/dL)				
< 200	251 (83.7)	82 (71.9)	169 (90.9)	<0.0001
≥ 200	49 (16.3)	32 (28.1)	17 (9.1)	
Triglycerides (mg/dL)				
< 150	215 (71.7)	62 (54.4)	153 (82.3)	<0.0001
≥ 150	85 (28.3)	52 (45.6)	33 (17.7)	
LDL-C (mg/dL)				
< 100	112 (37.3)	33 (28.9)	79 (42.5)	0.019
≥ 100	188 (62.7)	81 (71.1)	107 (57.5)	
HDL-C in Males (mg/dL)				
< 40	71 (38.4)	30 (47.6)	41 (33.6)	0.063
≥ 40	114 (61.6)	33 (52.4)	81 (66.4)	
HDL-C in Females (mg/dL)				
< 50	26 (22.6)	9 (17.6)	17 (26.6)	0.256
≥ 50	89 (77.4)	42 (82.4)	47 (73.4)	

Data presented as frequency (%); Chi square test, p<0.05 significant; BP: Blood pressure, LCL-C: Low density lipoprotein cholesterol, HDL-C: High density lipoprotein cholesterol

DISCUSSION

Present study identifies significant association of NAFLD with anthropometric and metabolic parameters in patients with T2D. Similar findings have been reported previously in many studies.[4,9-12] These findings corroborate NAFLD as risk factor for increased CVD risk.[13] Fatty liver was evident in 38% of the diabetic patients in present study. This is lower as compared findings of Rao et al reporting prevalence of 64.2% in T2D.[12] From a rural population, Majumdar et al reported prevalence of 30.7% in adults including those with or without T2D.[10]

Risk of NAFLD is increased significantly in diabetes as suggested by a study from Mohan et al.[14] Study found significantly higher prevalence of NAFLD (54.5%) in patients with diabetes in comparison to pre-diabetes (33%), isolated impaired glucose tolerance (32.4%), isolated impaired fasting glucose (27.3%) and normal glucose tolerance (22.5%). A comparative evaluation of anthropometric and metabolic risk factors in NAFLD cases is shown in Table 4.[9,15-20] These findings suggest significant association of NAFLD with anthropometric measurements and metabolic parameters and cardio-metabolic risk factors. We found no association with any glycemic parameters and NAFLD. This contrasts with other studies who reported higher HbA1c or FBG levels as evident from Table 4. But some reports also have found similar results as cited in table 4. This probably suggests that NAFLD is more co related with duration of diabetes and its long-term control as well as with the degree of lipotoxicity, dyslipidaemia, insulin resistance and obesity than glycemic parameter at any single point of time.[21] Further, genetic factors may also play role in development of NAFLD.[22]

There is significant association of NAFLD with hypertension (HTN). Ryoo et al identified clinical association between NAFLD and development of HTN reported increasing rates of HTN with increasing severity of NAFLD. NAFLD is an independent risk factor for development of HTN. Further, altered dipping status of blood pressure has also been reported to be associated with NAFLD and could possible because of insulin

resistance in NAFLD cases.[24] NAFLD is now evolving as potential target for T2D treatment because of its association with insulin resistance. NAFLD increases risk of developing diabetes and once it is established, diabetes further contributes to the progress of NAFLD.[25] Thus, forming a vicious cycle contributing to cardio metabolic risk factors for micro and macrovascular complications in future. This results in deranged glycemic control with changes in lipid levels and increasing obesity. Thus, NAFLD can be considered as a target to treat in diabetics especially those with significant fibro-progression and relevant family history of metabolic complications.

Table 4: Comparative evaluation of anthropometric and metabolic factors associated with NAFLD.

Parameter	Our finding	Ferreira et al.[16]	Agrawal et al.[15]	Somalwar et al.[19]	Ortiz-Lopez et al.[17]	Pat et al.[18]	Targher et al.[20]	Sharavana n et al.[9]
Weight (Kg)	68.1± 13.3*	79.8 ± 14.1*	75.9± 22.4	-	-	68.9± 11.1	-	-
BMI (Kg/m2)	27.0± 5.2*	31.9± 4.3*	27.5± 3.99*	26.97± 1.78*	-	27.2± 6.7*	28.3± 4*	29.54± 2.67*
WC (cm)	98.5± 11.5*	106.8± 10.3*	-	93.66± 6.66*	-	-	-	101.63± 8.36*
WHR	0.92± 0.07*	1.0± 0.1	0.97± 0.15	-	-	0.93± 0.16*	-	-
HbA1c (%)	8.4± 1.7	8.8± 2.1	8.0± 1.6	7.86± 0.59*	5.8 6± 0.1*	9.46± 4.7	7.3± 1.1*	10.1± 2.46*
FBG (mg/dL)	188.6± 91.6	177.7± 64.4	161.3± 64.44	-	109± 6.1*	-	-	-
PPBG (mg/dL)	244.3± 79.3	206.0± 85.3	226.9± 88.4	-	-	-	-	-
SBP (mmHg)	140.4± 29.0*	-	137.6± 15.9*	147.58± 13.40*	-	-	139.0± 12.0*	-
DBP (mmHg)	90.8± 20.8*	-	84.0± 7.74	92.05± 8.82*	-	-	85.0± 10.0*	-
TC (mg/dL)	181.4± 51.2*	195.9± 46.0	180.2± 30.8	255.23± 31.80*	187.0± 4.0	249.9± 37.0*	-	203.74± 27.18*
TGs (mg/dL)	156.4± 62.5*	185.0± 76.4	162.8± 65.4*	177.40± 18.91*	169.0± 8.0*	224.9± 71.6*	1.68± 1.0*#	205.81± 50.29*
LDL (mg/dL)	120.3± 27.8*	112.2± 38.0	102.7± 29.1$	111.66± 9.83	117.0± 3.0	170.8± 20.5*	3.37± 0.4#	125.43± 26.57*
HDL (mg/dL)	42.4± 6.4*	48.0± 11.2	42.2± 9.8*	37.05± 5.74*	38.0± 1.0*	31.2± 10.2*	1.34± 0.4*#	41.57± 5.03*

Limitations of present study

We did not evaluate the effect of treatment on NAFLD. Assessing degree of NAFLD with respect to necro-inflammation and fibrosis and its association with CVD risk factors would have highlighted the importance of reversal of NAFLD in early stages in patients with T2D. Assessing dietary pattern and exercise association with NAFLD is necessary as it may be valuable factor in determining the severity of NAFLD.

CONCLUSION

NAFLD has significant association with anthropometric parameters and metabolic risk factors in type 2 diabetes. In present study presence of NAFLD is not correlated with glycemic parameters. This association suggests a possible link between NAFLD and increased risk for CVD. Given the pathophysiology and its implications in type 2 diabetes, NAFLD can be considered as a target to reduce CVD risk in future. A prospective study evaluating NAFLD as potential target for treatment and its role in determining CV outcomes in T2D is needed.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Bellentani S, Marino M. Epidemiology and natural history of non-alcoholic fatty liver disease (NAFLD). Ann Hepatol. 2009;8(1):s4-8.
2. IDF Diabetes Atlas 7th Edition, 2015. International Diabetes Federation. 2015. Available from

http://www.diabetesatlas.org/ resources/ 2015-atlas.html Accessed on 02 October 2016.
3. Preiss D, Sattar N. Non-alcoholic fatty liver disease: an overview of prevalence, diagnosis, pathogenesis and treatment considerations. Clin Sci (Lond). 2008;115(5):141-50.
4. Kalra S, Vithalani M, Gulati G, Kulkarni CM, Kadam Y, Pallivathukkal J, et al. Study of prevalence of nonalcoholic fatty liver disease (NAFLD) in type 2 diabetes patients in India (SPRINT). J Assoc Physicians India. 2013;61(7):448-53.
5. Roden M. Mechanisms of Disease: hepatic steatosis in type 2 diabetes--pathogenesis and clinical relevance. Nat Clin Pract Endocrinol Metab. 2006;2(6):335-48.
6. Harris EH. Elevated Liver Function Tests in Type 2 Diabetes. Clin Diabetes. 2005;23(3):115-9.
7. Liu H, Lu HY. Non-alcoholic fatty liver disease and cardiovascular disease. World J Gastroenterol. 2014; 20(26):8407-15.
8. Singh D, Das CJ, Baruah MP. Imaging of non-alcoholic fatty liver disease: A road less travelled. Indian J Endocrinol Metab. 2013;17(6):990-5.
9. Sharavanan TKV, Premalatha E. Prevalence of non-alcoholic fatty liver disease in type 2 diabetes mellitus patients in a rural health care hospital. Sch. J. App. Med. Sci. 2015; 3(5A):1834-7.
10. Majumdar A, Misra P, Sharma S, Kant S, Krishnan A, Pandav CS. Prevalence of nonalcoholic fatty liver disease in an adult population in a rural community of Haryana, India. Indian J Public Health. ndian J Public Health. 2016;60(1):26-33.
11. Nagaraj S, Kiran SS, Gandham R, WDSC R, Nagaraja MR, AN S, et al. Study of prevalence of non alcoholic fatty liver disease in type 2 diabetes mellitus patients and variations in liver function tests , lipid profile and mean platelet volume in patients with fatty liver in comparison with patients without fatty liver. Int J Res Med Sci. 2016;4(3):871-6.
12. Rao SV, Sikariya KK. Prevalence and Risk Factors of Nonalcoholic Fatty Liver Disease in Type 2 Diabetes Mellitus in a Tertiary Care Centre In Western India. IOSR J Dental Med Sci. 2016;15(2):1-7.
13. Targher G, Arcaro G. Non-alcoholic fatty liver disease and increased risk of cardiovascular disease. Atherosclerosis. 2007;191(2):235-40.
14. Mohan V, Farooq S, Deepa M, Ravikumar R, Pitchumoni CS. Prevalence of non-alcoholic fatty liver disease in urban south Indians in relation to different grades of glucose intolerance and metabolic syndrome. Diabetes Res Clin Pract. 2009;84(1):84-91.
15. Agarwal AK, Jain V, Singla S, Baruah BP, Arya V, Yadav R, et al. Prevalence of non-alcoholic fatty liver disease and its correlation with coronary risk factors in patients with type 2 diabetes 2671. J AssocPhysicians India. 2011;59:351-4.
16. Ferreira VSG, Pernambuco RB, Lopes EP, Morais CN, Rodrigues MC, Arruda MJ, et al. Frequency and risk factors associated with non-alcoholic fatty liver disease in patients with type 2 diabetes mellitus. Arq Bras Endocrinol Metabol. 2010;54(4):362-8.
17. Ortiz-Lopez C, Lomonaco R, Orsak B, Finch J, Chang Z, Kochunov VG, et al. Prevalence of prediabetes and diabetes and metabolic profile of patients with Nonalcoholic Fatty Liver Disease (NAFLD). Diabetes Care. 2012;35(4):873-8.
18. Pai S, M C, Madi DR, Achappa B, Unnikrishnan. Non-alcoholic fatty liver disease in patients with type 2 diabetes mellitus. Int J Biol Med Res. 2012;3(3):2189-92.
19. Somalwar A, Raut A. Study of association of non-alcoholic fatty liver disease (NAFLD) with micro and macrovascular complications of type 2 diabetes mellitus (T2DM). Int J Res Med Sci. 2014;2(2):493-7.
20. Targher G, Bertolini L, Padovani R, Rodella S, Tessari R, Zenari L, et al. Prevalence of Nonalcoholic Fatty Liver Disease and Its Association With Cardiovascular Disease Among Type 2. Diabetes Care. 2007;30(5):1212-8.
21. Kwok R, Choi KC, Wong GL-H, Zhang Y, Chan HL-Y, Luk a. O-Y, et al. Screening diabetic patients for non-alcoholic fatty liver disease with controlled attenuation parameter and liver stiffness measurements: a prospective cohort study. Gut. 2015;1-10.
22. Dowman JK, Tomlinson JW, Newsome PN. Pathogenesis of non-alcoholic fatty liver disease. Q J Med. 2010;103(2):71-83.
23. Ryoo J, Suh YJ, Shin HC, Cho YK, Choi J. Clinical association between non-alcoholic fatty liver disease and the development of hypertension. J Gastroenterol Hepatol. 2014;29(11):1926-31.
24. Latea L, Negrea S, Bolboaca S. Primary non-alcoholic fatty liver disease in hypertensive patients. Australas Med J. 2013;6(6):325-30.
25. Fruci B, Giuliano S, Mazza A, Malaguarnera R, Belfiore A. Nonalcoholic fatty liver: A possible new target for type 2 diabetes prevention and treatment. International Journal of Molecular Sciences. 2013;14:22933-66.

Cite this article as: Khan SS, Kannu NS, Patil SS, Katekhaye VM. Association of non-alcoholic fatty liver disease with anthropometric and metabolic parameters in type 2 diabetes: a retrospective analysis. Int J Res Med Sci 2017;5:225-30.