ISSN 2515-8260 Volume 10, Issue 05, 2023

Role of Ncct to Correlate Association of Pancreatic Fat Content with Development of Type 2 Diabetes Mellitus – A Retrospective Study.

Dr Aysha Nazar[1], Dr Devdas Acharya[2]

[1]Post Graduate, The Department of Radiodiagnosis, Yenepoya Medical College, Mangalore, India.
[2]Professor, The Department of Radiodiagnosis, Yenepoya Medical College, Mangalore, India.

ABSTRACT

Aims and Objectives – The Aim of the study is to evaluate the correlation of pancreatic fat content as quantified by non contrast CT with development of type II diabetes mellitus.

Methodology – The study is a retrospective case control study done on 37 cases in Yenepoya medical college diagnosed with type II diabetes mellitus for whom unenhanced CT abdomen are taken and were compared with a control group with no diabetes in the current status and without known metabolic syndrome, or pancreatic diseases . Pancreatic and splenic attenuation were measured as in NCCT and two CT indices - Pancreatic attenuation - splenic attenuation (P-S)and Pancreatic attenuation / splenic attenuation (P/S) values were calculated.

Statistical correlation was done with pancreatic fat measurement indices in cases and controls to see for correlation between pancreatic fat content and development of type II diabetes mellitus.

Results – A total of 74 participants ,37 cases and 37 controls were evaluated. 54.1% were males among the cases and control groups while 45.9% were females in both the groups. Mean age of cases was 56.08 years while in controls was 50.81 years. The mean pancreatic attenuation was 40.63 among cases and 46.90 among controls. Mean difference between pancreatic and splenic attenuation (P-S) among cases was found to be -12.508 and among controls was -4.59 while mean pancreatic splenic attenuation ratio (P/S) among cases was 0.748 and among controls was 0.899 .

Our data indicate that pancreatic fat content is increased in T2DM patients.

Conclusion - Pancreatic fat content is increased in type II diabetes mellitus patients when compared to healthy individuals . Pancreatic attenuation, difference between pancreatic and splenic attenuation (P-S) and pancreatic splenic attenuation ratio (P/S) as measured in NCCT are found as reliable parameters for assessment of pancreatic fat density. Hence this study suggests the usefulness of unenhanced CT for the noninvasive assessment of pancreatic fat content and its potential role in screening of patients at risk for developing T2DM.

Key words – Type II diabetes mellitus , NCCT , Pancreatic attenuation, Splenic attenuation.

1. INTRODUCTION

The pancreas has a major role in diabetes mellitus, a progressive disease characterized by chronic hyperglycaemia caused due to insulin resistance and/or beta cell dysfunction and

ISSN 2515-8260 Volume 10, Issue 05, 2023

death (1). Fatty infiltration of pancreas, which can occur in patients with non-alcoholic fatty liver disease can trigger inflammatory cascades (2). Accumulation of fat in the pancreas is recognized as a reason for pancreatic dysfunction and for the apoptosis of nonadipocytes through lipoapoptosis, finally leading to diabetes (2). Loss of Beta cells secondary to apoptosis leads to a reduction in beta cell mass. However, blood glucose levels do not rise unless pancreatic insulin secretory function has declined by approximately 50%, and the subsequent gradual deterioration of blood glucose control is related solely to declining beta cell competence. Thus, it is important to have a reliable, non-invasive method for quantification of pancreatic fat.

Various imaging modalities like ultrasonography (US), CT, magnetic resonance (MR) imaging have been utilized to study quantification of pancreatic fat (1). But, US examination of pancreatic fat can be of limited value because of the location of the pancreas behind the stomach or colon (2) and as it does not provide reliable quantitative information.

Even though MR imaging (including MR spectroscopy) has the potential to allow quantification of fat content, fat quantification of the pancreas is far challenging as pancreas is prone to MR chemical shift artifacts due of its relatively small size, irregular morphology, and location in the middle of the abdomen surrounded by visceral fat (2) Thus, computed tomography (CT) may be a more practical, non-invasive imaging modality for the quantification of fat in pancreas because of its availability, cost effectiveness and short acquisition time. Pancreatic fat can be quantified by using CT and CT shows fatty infiltration in an organ as a decrease in attenuation (2).

AIMS AND OBJECTIVES

AIMS

To evaluate the correlation of pancreatic fat content as quantified by non contrast CT with type II diabetes mellitus.

OBJECTIVES

1. To measure pancreatic fat content by two NCCT indices - difference between pancreatic and splenic attenuation and pancreas-to splenic attenuation ratio.
2. To evaluate the correlation between pancreatic fat content as measured as by NCCT in patients with type II diabetes mellitus and controls.

3. METHODOLOGY

a) STUDY DESIGN- Retrospective case control study.

b) MATERIALS AND METHODS:

Approval of the Institutional ethics committee will be taken before conducting the study. The study will be conducted in accordance with the ethical norms as laid down in the Declaration of Helsinki. Strict confidentiality of the information collected will be maintained. All the data will be saved in a private laptop which is password protected. Only researchers and guides will have access to the data. The requirement for informed patient consent will be waived.

A retrospective study will be done on 37 cases in Yenepoya medical college diagnosed with type II diabetes mellitus for whom unenhanced CT abdomen are taken . A control group with no diabetes in the current status and without known metabolic syndrome, or pancreatic diseases ,with unenhanced CT done will also be identified.

Pancreatic attenuation will be measured in three ROIs , in the region of head,body and tail of pancreas with areas of 1.0 cm2 . We will consider the mean CT attenuation of the three

ISSN 2515-8260 Volume 10, Issue 05, 2023

ROI measurements as the representative measurement of fat content in pancreas for each subject. Splenic attenuation will also be measured on unenhanced CT images by averaging the measurements in Hounsfield units from three 1-cm2 ROIs different parts of the spleen.From the above pancreatic and splenic attenuation measurements, P - S and P/S, values will be calculated,where P indicates the pancreatic attenuation and S indicates the splenic attenuation.
Statistical correlation will be done with pancreatic fat measurement indices in cases and controls to see for correlation between pancreatic fat content and development of type II diabetes mellitus.

c) SOURCE OF DATA/SAMPLING METHOD:

Patients attending Yenepoya Medical College Hospital, Mangalore who meet the inclusion and exclusion criteria.

d) SAMPLE SIZE.

a) **Sampling technique:** Convenient sampling.
b) **Details of clinical examination (if any): N**il.
c) **Details of study like questionnaire: Nil**
d) **Validation of study tool (if applicable) (if any):** Nil

e)SAMPLE SIZE CALCULATION: Formula used:

$$N = \frac{2(Za+Zb)^2\ SD^2}{d^2}$$

Where,
Za =1.96 for 95% confidence interval
Zb = 0.84 for 80% statistical power
SD = pooled standard deviation of P/S among cases and controls = 0.15 [1]
d = margin of error i.e. mean difference of P/S among cases and controls =0.1

Therefore, minimum samples required in each group is **37.**
Total study participants 74 (37 cases and 37 controls)

e) INCLUSION CRITERIA

1. CASES – Patients who are diagnosed with type II diabetes mellitus for whom unenhanced CT abdomen pelvis are taken.

2. CONTROLS – Patients with no history of type II diabetes mellitus, metabolic syndrome, or pancreatic disease until the date of discharge at the study period, for whom unenhanced CT abdomen pelvis are taken.

f) EXCLUSION CRITERIA

1. Patients with any known diseases of pancreas.
2. Patients with history of pancreatic surgery.

ISSN 2515-8260 Volume 10, Issue 05, 2023

3. RESULTS

Table 1: Comparison of gender between cases and controls

Gender	Cases	Controls	Total	Test statistics	P value
Male	20(54.1)	20(54.1)	**40(54.1)**	0.000	1.000
Female	17(45.9)	17(45.9)	**34(45.9)**		
Total	**37(100.0)**	**37(100.0)**	**74(100.0)**		

Test used: Chi square test
*p value <0.05 is statistically significant

Table 2: Comparison of age between cases and controls

		Mean	SD	Median	(q1, q3)	P value
Age[a]	Cases	56.081	11.670	57.0	(47.0,62.0)	0.099
	Controls	50.811	15.244	50.0	(37.0,61.0)	

Test used: [a]Independent sample t test,
*p value <0.05 is statistically significant

Table 2: Comparison of study variables between cases and controls

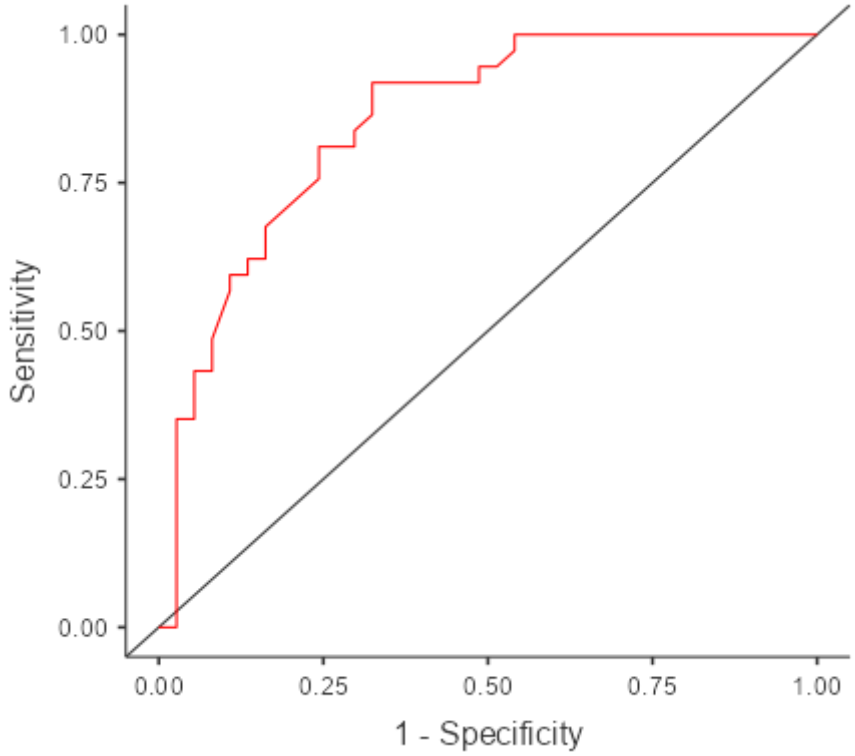
		Mean	SD	Median	(q1, q3)	P value
Hba1c[b]	Cases	8.968	2.367	8.500	(6.90,8.50)	0.0001*
	Controls	5.608	0.462	5.600	(5.30,5.90)	
Pan attntn[a]	Cases	40.627	5.546	40.000	(36.30,45.0)	0.0001*
	Controls	46.903	4.236	46.000	(44.30,49.00)	
splenic att[a]	Cases	53.800	4.791	54.000	(50.0,58.0)	0.007*
	Controls	51.100	3.418	51.000	(49.0,53.0)	
P-S[b]	Cases	-12.508	6.788	-12.800	(-16.30, -9.00	0.0001*
	Controls	-4.592	5.364	-6.000	(-8.40, -1.00)	
P/S[a]	Cases	0.748	0.096	0.740	(0.700,0.810)	0.0001*
	Controls	0.899	0.095	0.890	(0.820,0.970)	

Test used: [a]Independent sample t test, [b]Mann Whitney U test
*p value <0.05 is statistically significant

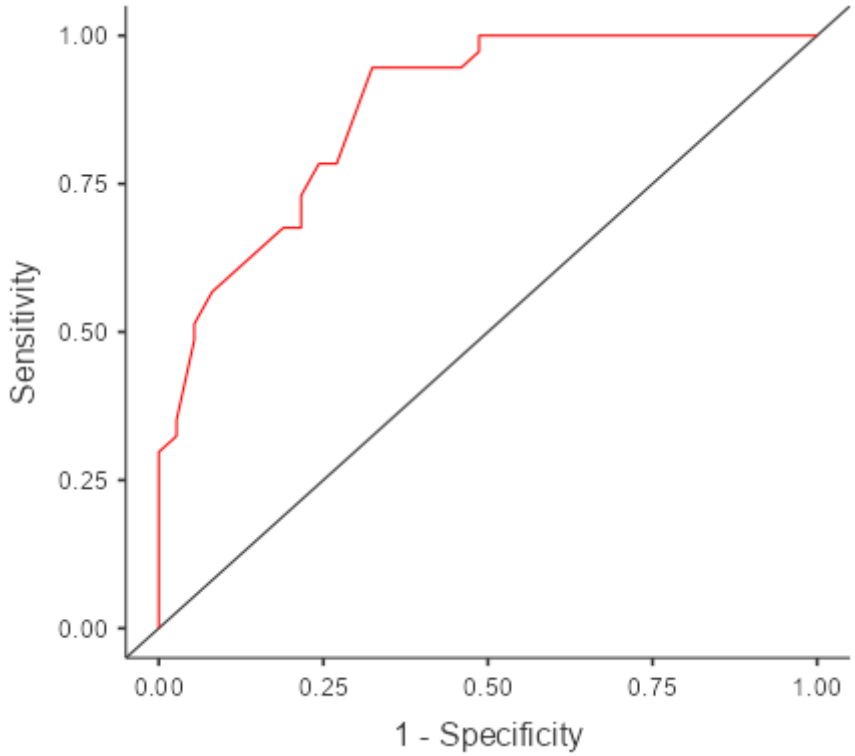
Parameters	Cut-off value	Sensitivity	Specificity	Accuracy	AUC	P value
P-S	-8.55	0.757	0.757	0.757	0.853	0.0001*
P/S	0.985	0.730	0.784	0.757	0.875	0.0001*

ROC Curve for P-S

ISSN 2515-8260 Volume 10, Issue 05, 2023



ROC Curve for P/S



4. DISCUSSION

Type 2 Diabetes mellitus (T2DM) is a major cause of morbidity and mortality causing harm to the patient and also causes major financial strain to the healthcare system. Hence from decades physicians have been trying to identify various risk factors for developing T2DM in patients to lessen their burden as well as health care cost. The present case control study is aimed to identify the correlation between pancreatic fat content and T2DM among 37 cases and controls attending a tertiary care hospital using unenhanced CT.

In our study ,54.1% were males in case and control groups while 45.9% were females in both the groups. Mean age of cases was 56.08 (11.67) years while in controls was 50.81 (15.24) years.

In the study done by Nadarajah et al in USA, the mean age of the controls was 52.5 (13.2) years and mean age of cases was 55.2 (14.4) years. Females in control and cases group were 55.3% and 55.6% respectively. In a study done by Kim et al in 2014 in China,the mean age of the study participants among controls was 60.6 (14.9) years and among cases was 62.2 (12.2)years. Males in control group were 66.67% while case group had 68.9% males. Desouza et al conducted a systemic review and meta analysis which complied many studies measuring the pancreatic volume and its correlation with diseases of which Lu et al, Macauley et al and Misra et al were few studies that compared the finding among healthy and diabetic patients. Lu et al showed a median age of 49 (41-59) years among controls and 61 (52-65) years among diabetic patients with 51.7% being males in controls and 70.4% being males in case group. Macauley et al showed a mean age of 59 (8.2) years among controls and 61.8 (6.4) years among diabetics. Misra et al study had 60% males in control group while in case group 89.2% was males. Mean age among controls was 27.8 (4.8) years and among cases it was 36.3 (5.1) years. The lower age group in this study might be because the study was done among individuals who were undergoing rehabilitation for alcohol abuse. All the studies had similar findings to that of our study and showed that the diabetic group had higher age compared to that of the control group and that males were more in diabetic group compared to that in control group except in Nadarajah et al study.

In the present study , mean HbA1c of cases was 8.96 (2.36) and controls was 5.60 (0.46). Mean HbA1c among diabetics in Nadarajah et al study was 7.44 (1.78) and in Macauley et al study it was 6.4 (0.1).

In the present study, the mean pancreatic attenuation was 40.63 (5.54) among cases and 46.90 (4.24) among controls.

Study		Pancreatic attenuation		P value
		Cases	Control	
Present study		40.63 (5.54)	46.9 (4.24)	<0.05
Lu et al, 2016		69.7 (21.5)	57.5 (21.9)	-
Macauley et al, 2015		82.6 (18)	55.5 (17.9)	<0.05
Misra et al, 2015		53.2 (20.8)	67.4 (24.9)	-
Yamazaki et al, 2016		46.0 (9.5)		-
Huang et al, 2023	Head	41.1 (8.)5	45.7 (4.6)	<0.05
	Body	44.4 (5)	47.4 (3.7)	<0.05
	Tail	44. (5)	47.6 (3.2)	<0.05

ISSN 2515-8260 Volume 10, Issue 05, 2023

All the studies showed that T2DM patients had significantly lower pancreatic attenuation compared to controls. Yamazaki et al study was a follow up study and showed that a higher baseline pancreatic attenuation was associated with decreased incidence of T2DM.

In the present study, mean difference between pancreatic and splenic attenuation (P-S) among cases was -12.508 (6.78) and among controls was -4.59 (5.36) while mean pancreatic splenic attenuation ratio (P/S) among cases was 0.748 (0.096) and among controls was 0.899 (0.095).In study done by Kim et al mean P-S among controls was -3.4 (4.4) and cases was -6.8 (7.1) while P/S was 0.9 (0.1) and 0.8 (0.2) respectively in controls and cases.
Our study showed that a cut off of -8.55 for P-S gave a sensitivity of 75.7%, specificity of 75.7% and accuracy of 75.7% while a P/S cut off of 0.985 gave a sensitivity, specificity and accuracy of 73%, 78.4% and 75.7% respectively. Kim et al study showed a sensitivity of 79.3% and a specificity of 42.4% for P-S with a cut off of -1.9 while for P/S a cut off of 0.9 gave a sensitivity of 69% and a specificity of 57.6%. P-S cut off in both the studies varied and hence the specificity value as well. For P/S ,our study gave higher sensitivity as well as specificity compared to the later study.

In conclusion, healthy individuals had higher pancreatic densities, which is seen decreased in patients with diabetes. Our data indicate that pancreatic fat content is increased in T2DM patients, which may reflect a paracrine effect of insulin. Insulin resistance causes increased insulin secretion by beta cells, and the higher local insulin concentration may induce fat deposition. The pancreatic lipid deposition may further impair islet function. The results of the present study indicate that the fat content in the pancreas holds promise in screening for patients at risk for developing T2DM and suggest the usefulness of unenhanced CT for the noninvasive assessment of pancreatic fat and its potential role in predicting glucose homeostasis.

5. CONCLUSION

- From this study, we conclude that pancreatic fat content is increased in type II diabetes mellitus patients when compared to healthy individuals .
- Pancreatic attenuation, difference between pancreatic and splenic attenuation (P-S) and pancreatic splenic attenuation ratio (P/S) are found as reliable parameters for assessment of pancreatic fat density.
- These CT indexes allow discrimination of patients with normal glucose metabolism from those with impaired glucose metabolism.
- NCCT being a more practical imaging modality due to its relatively lower cost and easy availability, makes it more accessible to patients of all socioeconomic strata.
- The faster scan acquisition time, less susceptibility to deleterious artefacts from patient motion, ability to be performed in patients with implanted electrical devices are its advantages.
- Hence this study suggests the usefulness of unenhanced CT for the noninvasive assessment of pancreatic fat and its potential role in predicting glucose homeostasis and hence its usefulness for screening of patients at risk for developing T2DM .

6. REFERENCES.

1. Steve V. DeSouza, Ruma G. Singh, Harry D. Yoon, Rinki Murphy, Lindsay D. Plank & Maxim S. Petrov (2018): Pancreas volume in health and disease: a systematic review and meta-analysis, Expert Review of Gastroenterology & Hepatology.
2. Kim SY, Kim H, Cho JY, Lim S, Cha K, Lee KH, Kim YH, Kim JH, Yoon YS, Han HS, Kang HS. Quantitative assessment of pancreatic fat by using unenhanced CT: pathologic correlation and clinical implications. Radiology.rsna. 2014 April ;Volume 271(1):104-12.
3. Nadarajah C, Fananapazir G, Cui E, Gichoya J, Thayalan N, Asare-Sawiri M, Menias CO, Sandrasegaran K. Association of pancreatic fat content with type II diabetes mellitus..Clinical Radiology. The Royal College of Radiologists. 2020 Jan;75(1):51-56.
4. Williams AJ, Thrower SL, Sequeiros IM, Ward A, Bickerton AS, Triay JM, Callaway MP, Dayan CM. Pancreatic volume is reduced in adult patients with recently diagnosed type 1 diabetes. The journal of clinical endocrinology and metabolism .2012 Nov;97(11):E2109-13.
5. Macauley M, Percival K, Thelwall PE, Hollingsworth KG, Taylor R. Altered volume, morphology and composition of the pancreas in type 2 diabetes. PLoS One.journal.pone. 0126825.2015 May 7;10(5)