A STUDY OF ABDOMINAL SUBCUTANEOUS AND VISCERAL FATUSINGST AND ARDMEA SUREMENTS AND ULTRA SONOGRAPHY IN TYPE 2 DIABETES MELLITUS PATIENTS AND THEIR CORRELATION WITH MICROVASCULAR COMPLICATIONS

Keyuri Mehta, Vijayashree Gokhale, Kunal Garg, Chirag Gurbani

Department of Medicine,

Dr.D.Y. Patil Medical College, Hospital & Research Centre,

Dr.D.Y.Patil Vidyapeeth, Pune, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

ABSTRACT

Background: India is becoming the "Diabetes Capital of the World". Body Mass Index and Waist to Hip ratio are standard anthropometric measurements.Assessing Subcutaneous and Visceral fat separately, we can get more insight into the pathophysiology of Diabetic complications.

Methodology : 100 diagnosed patients of Type 2 Diabetes Mellitus ranging from18-80 years of age were investigated for subcutaneous fat and sonography guided visceral fat and evaluated with grades of diabetic microvascular complications.

Data analysis was done using SPSS (Statistical Package for Social Sciences) Software version20.

Results and Conclusions: In our study,subcutaneous fat was increased in29% of the population, while Visceral Fat by Sonography assessment was raised in 73% of study subjects. Significant correlation was seen with Retinopathy and Nephropathy for both Subcutaneous and Visceral fat, while Neuropathy correlated with raised subcutaneous fat.

Keywords: subcutaneous and visceral fat, microvascular diabetic complications

INTRODUCTION

Diabetes Mellitus an endocrinological disorder of varied aetiology,characterized by chronic hyperglycaemia along with disturbed metabolism offats, carbohydrates and proteins resulting either due to decreased insulinsecretion, increased glucose production or decreased glucose utilizationultimately leading to multiorgan dysfunction 1 Insulin resistance, which is theprimary driver of both hyperglycaemia and compensatory hyperinsulinemia, isthe most important element in causing this condition. Diabetic Patient isvulnerable to the effects of hyperglycaemia-induced oxidative stress, which canresult in damage to liver tissue. This is then followed by a disruption in themetabolism of proteins, carbohydrates, and lipids, which ultimately results in anincrease inoxidative stressandfurthersetsoffthechainreactionof inflammation.Asignificantnumberofpatientswhohavetype2diabetesdevelopnon-alcoholicfattyliverdisease(NAFLD)alongwithitsinflammatoryconsequence, Non-Alcoholic Steatohepatitis (NASH). The high prevalence of NASH inpatients with type 2diabetes contributestothe development of additional problems, includingcirrhosis of the liverandhe patocellula rcancer.

Diabetes can, in certain people, lead to a high number of fat cells beingdeposited in the liver, which can then culminate in fatty liver disease andNAFLD. As a consequence of this, about 2–3 percent of people who haveNAFLD also develop a condition known as non-alcoholic steatohepatitis, whichischaracterisedbyinflammation,necrosis,andfibrosisintheliver(NASH). Injuredorfibroticliverswilleventuallydevelopcirrhosis,whichwillleadtotheformationofHCCsand, ultimately,liverfailure.

Subcutaneous fat measured by the use of vernier callipers and Visceral fatassessedbyultrasoundmayhavedifferenteffectsonDiabeticcomplications.This study attempts to correlate these 2 types of Fat in Diabetic Patients withMicrovascularComplications.

AIMS:To studya bdominals ubcutaneousandvisceralfatin type 2diabetesmellitus patients by using standard measurements and ultrasonography andcomparing the values to microvascular complications of diabetes mellitus.OBJECTIVES:

- Tomeasureabdominalsubcutaneousfat usingthestandard vernier callipers
- To measure abdominal visceral fat using the ultrasonography of stage ofliverfat
- BodymassindexandWaisthipratiowillbecalculated

- The above to be correlated with the presence or absence of microvasculardiabeticcomplicationslikeneuropathy,nephropathyandretinopathy.

MATERIALSANDMETHODS

100 patients from General Medicine OPD, Specialty Diabetes OPD and Wards enrolled for study were explained the procedure and the purpose of the

study,informedconsentwastakenfromthepatient.Detailsofhistoryasdemographic,personal, family history, and any significant past history were recorded in studyproforma. Required physical examination and necessary investigations weredone.

StudywasconductedinamedicalcollegeandHospitalinMaharashtra,India.Period of study was from July 2020 to September 2022, in type 2 diabetesmellitus patients. Vernier callipers used for measuring subcutaneous fat. Usgmeasuredliverfat.

INCLUSIONCRITERIA

- Patientsintheagegroupof18-80 years,maleor femaleDiagnosedpatients ofType
- 2DiabetesMellitusby

EXCLUSIONCRITERIA

PatientswithestablishedLiver,Kidney,Eyedisease,orNeuropathy,patientsonsteroids,andPregnant patients.

DATAANALYSIS

Datacollected,andtabulatedinMicrosoft

ExcelinMasterChart.AnalysisdoneusingSPSS(StatisticalPackageforSocialSciences)Software version20.

Categorical variables expressed in terms of frequency and percentage andcontinuous variables in terms of mean and Standard Deviation. Associationbetween obesity and microvascular complications were analysed using chisquaretest.ANOVAtestwasappliedtofindanydifferenceinmeanvalueof

study of variables across patient groups with $p<0.05$ as statistically significantvalueat95%Confidenceinterval.

RESULTS

:Inourstudy,meanagewas 55.4yrs.,M:F57:43,meandurationof

Diabetes
was8.5yrs.,ofwhich59%hadgoodcontrolofDiabetesmeasuredbyHbA1c.Dyslipidaemiaofhigh LDLlevelswasseenin60%.

Of the study population BMI measured, 45% were overweight, 51% were inobeseclass1category,3%obeseclass2andonly1%wereinthenormalrange.

SubcutaneousFat
measuredbyVerniercallipersshowed29%wereinleancategory,49%inaveragecategoryand29%ina bove averagecategory.

USGgrade1fattyliverwas seenin51%andgradeIIin22%.

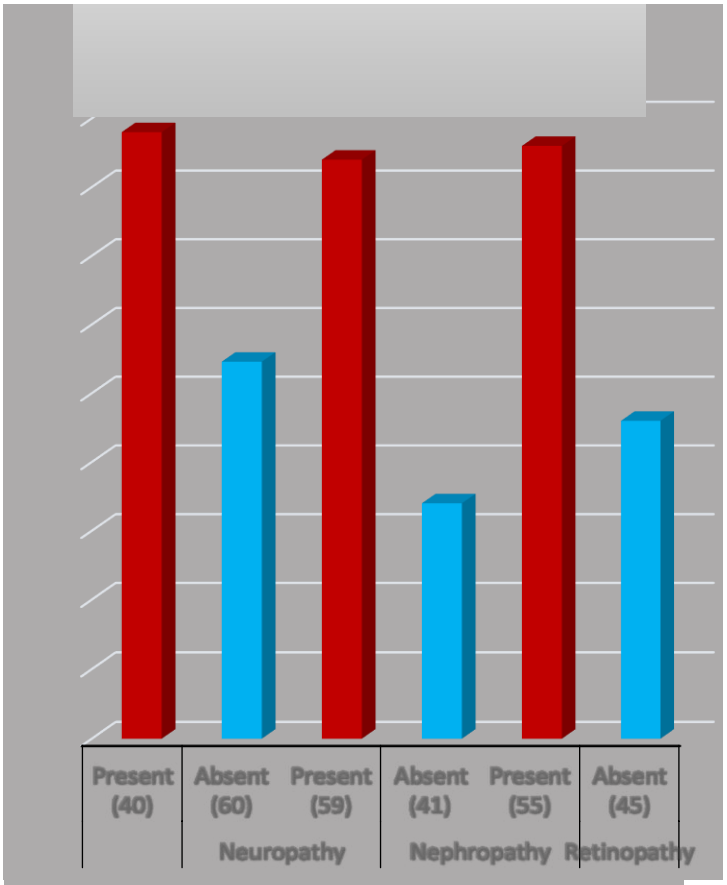
Increased Subcutaneous fat correlated with Retinopathy, Nephropathy andNeuropathy.VisceralFatintheformofFattyliversh owedcorrelationwithNephropathyand Retinopathybutnot with neuropathy.

Comparisonofvariableswithsubcutaneousfat

Variables	Subcutaneousfat	Mean	Std.Deviation	Pvalue
Neuropathy	Present(40)	22.9	4.2	0.05
	Absent(60)	21.23	4.24	
Nephropathy	Present(59)	22.7	4.24	0.01
	Absent(41)	20.2	4.17	
Retinopathy	Present(55)	22.8	4.21	0.05
	Absent(45)	20.8	4.24	

ComparisonofvariableswithUSGgradeofliver fat

Variables	USG grade ofliverfat	Mean	Std. Deviation	Pvalue
Neuropathy	Present(40)	1.07	0.69	0.14
	Absent(60)	0.86	0.7	
Nephropathy	Present(59)	1.06	0.69	0.04
	Absent(41)	0.78	0.68	
Retinopathy	Present(55)	1.07	0.6	0.05
	Absent(45)	0.8	0.75	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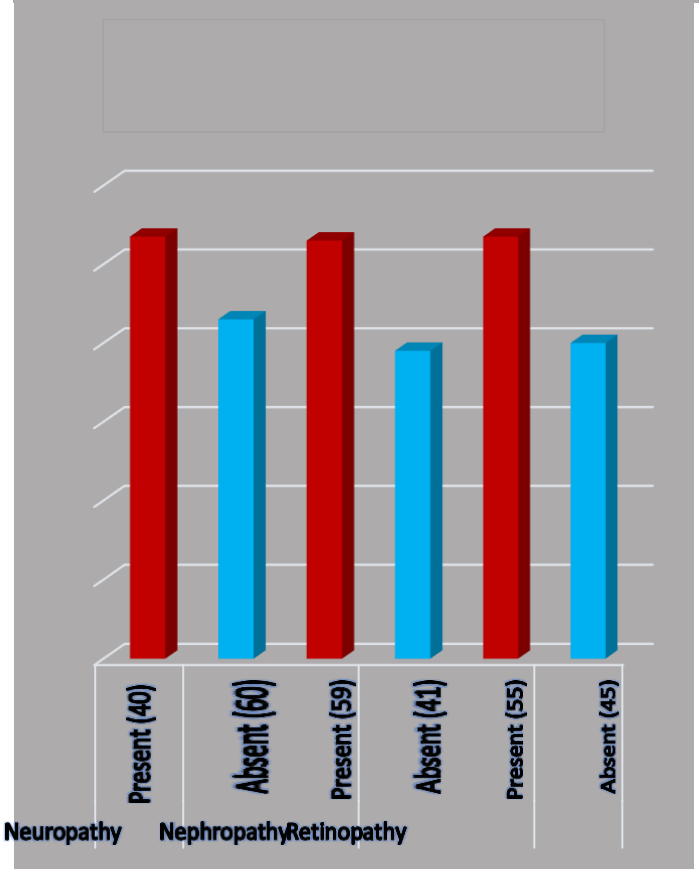
Present (59)
Absent (41)
Present (55)
Absent (45)
Neuropathy
Nephropathy
Retinopathy


Present (40)
Absent (60)
Present (59)
Absent (41)
Present (55)
Absent (45)
Neuropathy
Nephropathy
Retinopathy

DISCUSSION:

Visceralandsubcutaneousadiposetissue,asmeasuredbyultrasonography,are substantiallyrelatedwithglucose metabolism,accordingtoresearchpublished in2015byPhilipsenetal.[1]Bertolietal.cametotheconclusionin2015thattheVisceral AdiposeTissue and SubcutaneousAdiposeTissuearebothindependentlyrelatedwithmetabolicsyndrome.[2]

Inthe studyfrom2009,Kimetal.came tothe conclusionthatoutof174 peoplewithabdominalobesity, 35ofthosepeopledidnothavevisceralobesity.However,88patients withvisceralobesitywere foundamongthegroupof peoplewhodidnothaveabdominal obesity(n =194).[3] Ascomparedtoourstudy where out of the 100 subjects a total of 73% showed visceral obesity ofvarious grades and 27% did not. A similar study conducted by Blumentals WAet al, in 2013, 29.5% of them were Overweight, 54.6% of them were ObeseClass 1,12.8%ofthemwere Obese Class2,15.0%ofthemwerenormalrange.[4]

Thepatientsinourstudyweresufferingfromdiabetesforanaveragedurationof 8 years. A similar study conducted by Lynne et al, in 1997, had the meanDuration of Diabetes 7 years (±6.6 years).[5] The 31% of diabetic patients hadpoor control of diabetes and had an hba1c of 9%. In our study, 65% had goodcontrolofdiabetesbyHbA1c.

Obesity, hypertension, and hypertriglyceridemia are significant type 2 diabetesriskfactors(DM).HjellvikVetaldeterminedtherelativesignificanceofthesethree risk factors in comparison to a number of other risk factors (such as non-fasting glucose) as DM predictors, as well as the risk that these three factorsalone and in combination pose. The incidence of DM ranged from 0.5% to19.7% in men and from 0.15% to 21.8% in women in the various groups ofBMI, triglycerides,anddiastolicbloodpressure.Thestrongestpredictorof incidentDMwasBMI,whichwasfollowedbywomen'striglyceride levelsandmen'sglucoselevels.Onlyslightlymoreaccuratepredictionsweremadewhen risk factors other than BMI, glucose, triglycerides, and blood pressure wereincludedinmultivariatemodels.Thebestindicatoroftype2diabeteswasBMI.The incidence of DM varied significantly with triglyceride levels and bloodpressure at specific BMI levels. Obesity and overweight are also closely relatedtoDM.ThepreventionofDMdependsonthepopulationatrisk being identified early.[6] Chen et al found that the Participants with any quartile ofSubcutaneous fat showed the positive associations between Visceral fat andnewlydiagnoseddiabetesrisk(allPfortrend0.001).However,amongparticipants in various visceral abdominal fat quartiles, there were only a fewsignificant associations between subcutaneous fat and risk of newly diagnoseddiabetes.Subcutaneousfatwasnegativelycorrelatedwithriskofnewlydiagnosed diabetes in women with visceral abdominal fat in the second quartile(P for trend = 0.024).[7] Vashist et al found that among people with diabetes, DRprevalencewas16.9%,STDR(sight-threatening)prevalencewas3.6%,andmildretinopathyprevalencewas11.8%.In ourstudy,55%showedpresenceofretinopathy of various grades.[8] Among the study population with Nephropathy,59% showed nephropathy and 41% did not have nephropathy. Similarly in astudy conducted by Unnikrishnan et al. they found that overt nephropathy waspresent in

2.2% of patients (95% CI: 1.51-2.91).[9] Among the study population40% showed presence of neuropathy (of various grades) and 60% did not showneuropathy. Jan-Willem G in march 2003, conducted a similar study in which96% showed grade 2 neuropathy.[10]There was a significant correlation betweentype 2 diabetes and visceral and central abdominal fat. Both measurements inurban Asian Indians with and without diabetes showed strong correlations witheach other, with waist circumference. Schulze et al corroborate with our studyresults.TheyfoundthatIndependentofageandotherindividualfactors,all

anthropometric measurements,includingestimatesofbodycomposition,were

significantly positively linked with diabetes in both men and women.[11] This wassupported by a study conducted by Mohan et al where they had found that incomparisontonon-diabeticparticipants, diabetes subjectshadconsiderably

more visceral (P = 0.005) and central abdominal (P = 0.011) fat. Both diabeticand

nondiabetic patients; waist circumference and Subcutaneous AbdominalFatdemonstratedahighconnectionwithvisceral(P0.01)andcentral abdominal (P 0.0001) fat. Even after correcting for age and sex, the results of alogistic regression analysis showed that visceral (odds ratio [OR] 1.011, P =0.004) and central abdominal (OR 1.001, P = 0.013) fat are linked to diabetes. Itwas concluded that there was a significant correlation between type 2 diabetesandvisceralandcentralabdominalfat.[12]Fatcellssecreteavarietyofinflammatory cytokines, once they have exceeded their capacity to absorb lipidsin circulation. As a consequence, fat deposit in extracellular tissues like muscle,the liver, and arterial walls, and the vicious cycle of inflammation starts. Thedevelopmentofatherosclerosisandotherproblemswouldbefurtherexacerbated,as would hyperlipidaemia and insulin resistance.[13] The liver, which is made up ofinsulin-sensitive tissues, is one of the key organs that is vulnerable to the effectsof hyperglycaemia-induced oxidative stress, which can result in damage to livertissue.Asaconsequenceofthis,about 2–3percent ofpeoplewhohaveNAFLD

alsodevelopaconditionknownasnon-alcoholicsteatohepatitis,whichischaracterisedbyinflammation,necrosis,andfibrosisintheliver(NASH).

Zhang et al indicated that the increased Fasting Blood Glucose levels might be ageneral pathophysiological property of diseased tissues or organs. This explainstheprevalenceofcomplicationsofthediabetesinourstudysubjects.[14]Abdominal obesity was associated with DPN. Insulin resistance might mediateobesity and DPN in middle aged subjects with T2DM.[15] Symptomatic DistalSensoryPolyneuropathyismoreprevalentinpeoplewithextrametabolicsyndrome components, regardless of glycemic status. However, it is still unclearwhether elementsof themetabolicsyndrome,includinghyperglycemia,areresponsiblefor thisconnection.Larger research with moreexactmetabolicmeasurements are required. Larger waist circumference and low HDL may berelatedwith Distal SensoryPolyneuropathy.[16] A study conductedby Sabrinaetalin 2019, showed a total of 127 cases had diabetic polyneuropathy. [17] In a studyconductedbyRameshKumaretal,stiffnessoflivermeasurementusingelastography or Fibroscan proved a better tool for assessment as compared toother non-invasive predictors of NAFLD and liver fibrosis.[18] A study by ChristinaDinaetal,identifiedtheFTOgeneonchromosome16q12.2leadingtoearlyonsetofchildhoodan dadultobesity.Thestudyshowedthathumanobesitywasrelatedtothe FTOgene andisa targetforfuturefunctionalanalyses.[19]

In a study conducted by Ronald Klein et al in 1996, proved that HbA1c

levels,wereagoodpredictorofdevelopmentofmicrovasculardiabeticcomplications.[20]

CONCLUSION

Inourstudy, wefound29%ofpatientswithincreasedSubcutaneousas wellasVisceral FatonUltrasound(73%).

Significantcorrelationwasfoundforthepresenceofneuropathy,nephropathy andretinopathyinthesepatientswheninvestigatedonthebasisofsubcutaneousfat. However, the ultrasonography grade of liver fat showed significantcorrelationonlywithretinopathyandnephropathybutnotneuropathy.

Clinical Implications: Assessment of Both Subcutaneous and Visceral fat isimportant in Diabetic Subjects on a regular follow up basis, so as to treat theunderlying conditions and prevent progress of Microvascular Complications ofDiabetes

LIMITATIONSOFSTUDY:Ourstudywas of100Type 2Diabeticsubjects

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DISCLAIMER

The products used for this research are commonly and predominantly useproducts in our area of research and country. There is absolutely no conflict ofinterest between the authors and producers of the products because we do notintend to use these products as an avenue for any litigation but for theadvancementofknowledge.Also,theresearchwasnotfundedbytheproducingcompanyratherit wasfunded bypersonaleffortsofthe authors.

CONSENT

Allauthorshavedeclaredthat“Writteninformedconsentweretakenfromallstudysubjects”.

ETHICALAPPROVAL

Allauthorsherebydeclarethatthestudywasapproved bytheInstitutionalethics sub- committee of Dr. D. Y. Patil Medical College, Hospital andResearchCentre,Pimpri(I.E.S.C./10/2020)

COMPETINGINTERESTS:Authorshavedeclaredthattherearenocompetinginterests.

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