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Evaluating Pancreatic index in Patients with and without Metabolic Syndrome

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ABSTRACT

BACKGROUND

Metabolic syndrome can be considered as a combination of metabolic disorders that may led to an increased risk of some diseases such type II diabetes, cardiovascular diseases, myocardial infarction, and is the cause of mortality from coronary artery disease. Its prevalence is particularly high in women. There is evidence that pancreatic fat, as a key factor in non-alcoholic fatty liver and metabolic syndrome, numerates as an early indicator of abnormal fat deposition.

METHODS

In this study, we enrolled 262 patients, who were admitted to Ali Ibn Abi Talib Hospital in Rafsanjan city, using the non-random-sequential method. Data collection tools were a questionnaire containing demographic characteristics (age, sex, history of diseases, etc.) and a checklist including MetS (based on NCEP/ATP III criteria and Diabetes Committee), pancreatic density (P), and spleen (S) and pancreatic index (P/S). One-way ANOVA and Post-Hoc and Chi-square tests were used for statically analyses.

RESULTS

The prevalence of metabolic syndrome was 34.8%, index of pancreas in the group without and with metabolic syndrome were 0.85 ± 0.11 and 0.74 ± 0.29 Hounsfield Units, respectively.

CONCLUSION

Compared with the group with at least one criterion and the group with the complete criteria ($p = 0.013$), pancreas index was higher in the group without metabolic syndrome.

KEYWORDS:
Type II diabetes, Metabolic syndrome, Cardiovascular disease

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INTRODUCTION

Considering the World Health Organization (WHO) report in February 2018, since 1975, obesity has almost tripled worldwide.[1] Obesity is a chronic disorder, characterized by weight increase accompanied by the accumulation

of excess adipose tissue.[2] Obesity is the strongest environmental factor associated with type II diabetes mellitus (DM-2), as well as being a risk factor for metabolic syndrome.[3,4] In the case of obese people, the mortality rate associated to cardiovascular disease is about 50% higher than in people with a normal weight. Also, metabolic syndrome is associated with a five-fold increase in the risk of DM-2, two times increase in the risk of cardiovascular disorder, [2-4] times increase in the risk of stroke, [3-4] times increase in the risk of myocardial infarction (MI), as well as, with a doubling of mortality rate associated with coronary heart disease.[5] The incidence of metabolic syndrome, especially in women and older patients, is rapidly increasing in the world.[6] Obesity and DM-2 are related to dyslipidemia and accumulation of splanchnic and ectopic fat, which are found in the liver, muscles, heart and pancreas and result in lipotoxicity in these organs.[7] Also, liposuction and infiltration in the pancreas is a mysterious manifestation of ectopic fat deposition in obesity.[8] Fat accumulation inside the pancreatic islet cells disrupts the function of the pancreatic beta cells.[9] The prevalence of fatty pancreas is 16-35 % in the United States and Asia.[10,11]

There is a significant relation between nonalcoholic fatty pancreatic disease (NAFPD) and nonalcoholic fatty liver disease (NAFLD) and also between these two and obesity. About 70% of patients with NAFLD present with NAFPD.[12] The amount of pancreatic fat is directly related to a person's age and body mass index (BMI). There is ample evidence for the role of pancreatic fat in the development of DM-2, metabolic syndrome, atherosclerosis, acute pancreatitis, and even pancreatic cancer. There is evidence that pancreatic fat can be used as an early indicator of abnormal fat deposition, which is a key factor in NAFLD and metabolic syndrome.[5] Also, in patients with fatty pancreatic, pancreaticoduodenectomy, as well as, pancreatic fistula increase the risk of blood loss during surgery that subsequently increased the risk of death.[13] Fatty pancreas as a common condition can be easily diagnosed but often ignored by physicians. CT scans without contrast agent injection is a very suitable way for the diagnosing pancreatic fat. However, using of magnetic resonance imaging (MRI) is the best method, which, according to past studies, are similar to histology in terms of reliability. Pancreatic fat needs more attention in clinical medicine and should be considered as an early indicator of ectopic fat deposition and insulin resistance in metabolic syndrome.[14] Lifestyle modification can prevent metabolic syndrome. Also, if high-risk people are identified, serious future complications can be prevented (cardiovascular disease, stroke, etc). Having a health society and reducing medical costs will be the least benefits of this prevention.

MATERIALS AND METHODS

This study was performed on 262 patients, who referred to the computed tomography (CT) scan department of Ali Ibn Abi Talib Hospital in Rafsanjan city, Kerman province. In this study, we enrolled patients that referred only for abdomen or pelvis CT scan for reasons other than trauma, pancreatic cancer, or other known diseases related to the pancreas and spleen. The patient's data were collected non-randomly and consecutively during 2018-2019. For all patients who referred to the hospital, a questionnaire containing demographic characteristics including age, sex, medical history, medication, as well as, blood biomarkers and past illness such as diabetes or high blood pressure, was completed. In this study, the standard of metabolic syndrome was selected based on the standard of NCEP/ATP III and Diabetes Committee (table 1).

According to Hounsfield, for all patients, spleen and pancreatic densities were measured at the maximum measurable level on abdominal transverse CT scan. The density of the pancreas was measured by selecting three points on the head, trunk, and tail of the pancreas. For calculating the pancreas index, the mean of the three measured densities were divided by the spleen density. Because of the access limitation to tissue samples, it was impossible to confirm the presence of glucose metabolism disorder or definitive fat deposition. In patients with abdomen and pelvis CT scan via contrast agent injection, the portal phase (70-60 seconds after injection of contrast agent) was used for measurement. The same images were used in patients with CT scans without injection of contrast agent; for these patients there were only one imaging phase. After filling the questionnaire, people were divided into three groups: 1. People who met the full criteria of metabolic syndrome, 2. People who have one or two criteria for this syndrome, 3. People who do

Table 1: Diagnosis of metabolic syndrome based on NCEP/ATP III criteria and Diabetes Committee

Variables	NCEP/ATP III	IDF Diabetes Committee Criteria
Central obesity (based on waist circumference)	Men > 102 cm, women > 88 cm	Special values
TG	150 ≥ or under treatment	
HDL	< 40 in men, < 50 in women	
BP	Systolic ≥ 130 or diastolic ≥ 85 mmHg	
FBS	≥ 100 or treatment of type 2 diabetes	
Diagnosis of metabolic syndrome:	There are three criteria	Central obesity with two other factors

NCEP/ATP III: National Cholesterol Education Program Adult Treatment Panel III,
IDF : International Diabetes federation, TG: Triglyceride, HDL; High-density lipoprotein, BP: Blood pressure, FBS: Fast Blood Sugar,

Table 2: Comparing the frequency of metabolic syndrome in both sexes

Variables			No metabolic syndrome criteria	Has 1-2 criteria for metabolic syndrome	Has complete criteria for metabolic syndrome	Total
Sex	Women	Number	9	54	55	118
		Percent	7.6%	45.8%	46.6%	100%
	Men	Number	34	38	17	89
		Percent	38.2%	42.7%	19.1%	100%
Total		Number	43	92	72	207
		Percent	20.8%	44.4%	34.8%	100%

not meet any of the criteria for metabolic syndrome. Then based on age and sex, pancreatic index (P/S) were compared in these groups. Data were analyzed in triplicate with GraphPad prism software and were expressed as mean±SE. Statistical significance was determined by Dunnett's t test and independent means by Student's t test. $p \leq 0.05$ was considered as statistically significant.

RESULTS

In this study, we enrolled 262 patients including 147 (56.1%) women and 115 (43.9%) men. The mean age of the cases was 52.4 years. In 43 (20.8 %) cases with a mean age of 39 years, none of the criteria for metabolic syndrome were seen. 92 (44.4 %) cases with a mean age of 52 years, showed partial metabolic syndrome criteria (stage 1-2). Also, 72 (34.8 %) with a mean age of 56 years, showed complete metabolic syndrome criteria. The incidence of metabolic syndrome was 34.8% (with 95% confidence interval, equivalent to 21-41%). Also, 65.2% of the patients did not show any metabolic syndrome. In the statistical analysis, difference among the age group without metabolic syndrome and the groups that had partial or complete criteria was significant, as the mean age of cases with the lowest metabolic syndrome criteria was higher than those without them. The incidence of metabolic syndrome among women was 46.6% (with 95% confidence interval, equivalent to 36-55%) and 19.1% (with 95% confidence interval, equivalent to 11-27%) among men (table 2). The relationship between sex and frequency of metabolic syndrome was significant, and it was higher in women ($p < 0.001$). The pancreas indices in the group without metabolic syndrome criteria, partial metabolic syndrome criteria, and complete metabolic syndrome criteria were 85 ± 0.11, 57.2 ± 88.2 and 57.2 ±2 0.2 Hounsfield units, respectively. This value was evaluated for overall cases and was obtained 0.77 ± 0.22 Hounsfield unit. Also, the pancreas index in the group without metabolic syndrome criteria were higher than the group with partial or complete criteria (tables 3 and 4).

DISCUSSION

The incidence of metabolic syndrome in this study, compared to studies conducted by Herningtyas and colleagues as well as Li and colleagues, was higher than the results obtained by these researchers.[15-18] However, compared to studies conducted by Suliga and co-workers, as well as Venugopal and colleagues, this value was lower than the results obtained by these researchers.[14, 19] In this study, the incidence of metabolic syndrome is

Table 3: Investigating the relationship between pancreatic density and metabolic syndrome criteria

Metabolic syndrome criteria	Number	Average pancreatic density	Standard deviation of pancreatic density
No metabolic syndrome criteria	43	78.89	24.77
Has 1-2 criteria for metabolic syndrome	92	67.13	23.56
Has complete criteria for metabolic syndrome	72	62.44	29.99
Total	207	68.15	26.85

Table 4: Investigating the relationship between pancreatic index and metabolic syndrome criteria

Metabolic syndrome citeria	Number	Average pancreas index	Standard deviation of the pancreas index
No metabolic syndrome criteria	42	0.85	0.11
Has 1-2 criteria for metabolic syndrome	92	0.75	0.18
Has complete criteria for metabolic syndrome	72	0.74	0.29
Total	206	0.77	0.22

consistent with the prevalence found by other researchers in other countries. Compared to other similar studies, it seems that the incidence of metabolic syndrome was higher in women group.[18,19] However, in some studies, the opposite results have been obtained.[15] Because of the traditional lifestyle in Iran, high incidence of metabolic syndrome seems more reasonable in women. Since different studies have been performed on specific target groups with a certain age range, it was not possible to compare the obtained results with high confidence. But the common outcome of all these studies, as well as our results, was the significant increase in the incidence of metabolic syndrome in parallel with age increasing. Our results confirmed that the density of the pancreas and, consequently, the pancreas index in normal individuals was higher than in people with at least one metabolic syndrome criteria. However, the lowest pancreas index was achieved for cases with complete metabolic syndrome, proving that an increase in fat deposition in the pancreatic tissue is consistent with an increase in metabolic syndrome criteria. These findings have already been proven by other researchers. According to the previously studies, conducted by researchers in patients with cardiovascular disorders and diabetes, more subcutaneous and visceral fat was deposited in these patients, which ultimately led to an increase in their pancreatic fat content.[20-22] The similar association between fatty pancreas and metabolic syndrome was found in one study.[23] Fatty pancreas was associated with high levels of visceral fat, increasing waist circumference, increasing ALT, AST, TG, HDL, FFA and GTP levels, as well as, increased total cholesterol and resistance to insulin. Compared with the control group, the prevalence of metabolic syndrome was higher in the group with fatty pancreas. In the other words, a number of metabolic syndrome indicators were considerably higher in the group with fatty pancreas.[23] One study on the prevalence of NAFPD and associated risk factors among hospitalized patient, showed that the incidence of NAFPD in adults was not only high (35%) but was also completely related to other metabolic disorders such as high blood pressure, blood sugar over 100 (mg/dl) and fat disorders, as well as sex and age,[24] In another study on the incidence of NAFPD in southern China and its association with NAFLD and metabolic parameters, the prevalence of NAFPD and NAFLD was associated with factors such as age, Bp, BMI, TG, HDL, LDL, and glucose levels. But the important finding was that NAFPD was significantly higher than non-alcoholic fatty liver, as NAFPD and NAFLD can address the body's metabolism. In another study, the relationship between pancreatic size and fat content in diabetic patients was compared to normal individuals. The most important point of this study was that the patients with diabetes showed decreased pancreas volume.[25,26] Zhi Dong and colleagues evaluated the potential of liver and pancreas fat in detecting glucose tolerance, and found that based on MRI results, the distribution of

fat in the liver and spleen was uniform, and a close relation was found between insulin resistance and beta cell function than FVF in the pancreas. Finally, this research group concluded that the fat content of the liver and pancreas, particularly for the liver, could be a biomarker for IGT and type II diabetes.[27]

CONCLUSION

Metabolic syndrome is preventable, when people with high-risk potential are diagnosed. According to this diagnosis, serious disorders include cardiovascular disease or stroke can be prevented continuously. Having a healthier and efficient society will be one of the least benefits of this prevention and will lower medical costs. Since metabolic syndrome leads to a very wide range of complications, it is necessary to be diagnosed at an early stage before serious disorders such as diabetes, cardiovascular disease, and pancreatic cancer occur. Fatty pancreas and many metabolic syndrome disorders can be prevented and even treated by lifestyle changes such as dietary modification and increased physical activity. However, periodic follow-up with ultrasound can be very beneficial. Also, to reach a better outcome, it is necessary to increase awareness for changing people's lifestyle. This modification is more important for countries that are different from other countries geographically and nutritionally.

ETHICAL APPROVAL

There is nothing to be declared.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this work.

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