

Clinical Forum

Pancreatic imaging by ultrasonography in type 1 diabetes mellitus

Ravi Rajput, Mani Ram, Sanjeev Maheshwari, RK Goyal, GL Verma
Department of Medicine, JLN Medical College & AG Hospitals, Ajmer, India

Abstract

Various types of morphological changes in pancreas have been demonstrated in patients with type 1 diabetes mellitus. We evaluated 35 patients suffering from type 1 diabetes mellitus and compared them with 15 age, sex and BMI matched healthy controls to assess the morphology of the pancreas by ultrasonography which is non-invasive, economic, simple and easily available. It was found that patients with type 1 diabetes mellitus have a reduction in total area of the pancreas, increased diameter of the main pancreatic duct and presence of fibrosis and calcification which was more pronounced in patients having longer duration of diabetes.

Keywords : *Type 1 diabetes mellitus, ultrasonography, pancreas*

Introduction

Various types of anatomic and pathologic changes in the pancreas have been described in type 1 diabetes mellitus.^{1,2} The size of the pancreas may be significantly reduced involving all portions of the gland simultaneously (head, body and tail) and there may be calcification, fibrosis, acinar atrophy with destruction of beta cells.³ Ultrasonography is easily available, economical, reliable and a non-invasive method for imaging.⁴ Reports about imaging of the pancreas are scanty in the literature, hence we conducted this study to learn about the various anatomic and pathologic changes occurring in the pancreas in patients with type 1 diabetes mellitus.

Patients and Methods

The present study was conducted in the

Correspondence to : Dr.Ravi Rajput, G-17, Naka Madar, Gandhi Nagar, Ajmer 305001 (Raj), India

Department of Medicine, JLN Medical College and Associated group of hospitals, Ajmer. The subjects selected for study were divided in two groups viz:

- a) Group I: 15 age, sex and BMI matched healthy controls.
- b) Group II: 35 patients with type 1 diabetes mellitus. This group was further subdivided depending on duration of diabetes.

Group A- Duration less than 5 years (n=15)

Group B- Duration 5-10 years (n=10)

Group C- Duration more than 10 years (n=10)

All the patients included in Group II had an episode of ketoacidosis during some part of their illness and required insulin for glycaemic control i.e. they were ketosis

prone. A detailed history and thorough clinical examination was performed in each subject.

Various morphologic and anatomic changes of the pancreas including the size of the pancreas, the visualisation of pancreatic duct and the presence of any fibrosis, calcification or acinar atrophy were identified using ultrasonography in each subject.

The ultrasonography was done by a single operator who did not know whether the subject was diabetic or a healthy control, using an EUB 145 machine with a linear/convex probe of 3.5-5 mega Hertz. The subjects were scanned after overnight fasting in the supine position with longitudinal and axial scans. The size of the pancreas was delineated by calculating the perimeter and total area of pancreas, expressed in cm^2 . The transverse diameter of the head of the pancreas was measured from the external border near the duodenal ansa to the isthmic region of the pancreas.

The sagittal scan of the head, body and tail of the pancreas was performed to measure the longitudinal diameter. The sum of the pancreatic diameters was calculated and confirmed with results obtained by measuring the area of the pancreas.

Visualisation of the pancreatic duct was done in the mid-line where the duct follows a straight course. It was seen as two strong parallel linear echos separated by the nonechogenic lumen. Normally, it is not visualised unless it is more than 2.5 to 3 mm in diameter. The presence of fibrosis or calcification was detected by the intensity of white echotexture.

Statistical analysis was performed by using Student *t* test and Pearson's coefficient and the results were expressed as mean \pm SD.

Results

The total area of the pancreas was significantly smaller in patients with type 1 diabetes mellitus when compared with healthy controls (Table1). With increasing duration of diabetes there was a reduction of the dimensions of the head, body, tail and total area of the pancreas which are more evident if diabetes is of more than 10 years duration. The diameter of the pancreatic duct was also increased along with the occurrence of fibrosis and calcification.

Discussion

Type 1 diabetes mellitus is characterised by the presence of "insulinitis" i.e. inflammation of islets which is accompanied with destruction of beta cells.⁷ Genetic factors may be responsible for insulinitis as 90% of patients with type 1 diabetes mellitus possess either HLA DR3 antigen, HLA DR4 antigen or both antigens.⁵ A strong association between type 1 diabetes mellitus and certain human leukocyte antigens encoded by the major histocompatibility region has been found (Atkinson, 1994).⁶ Hence susceptibility to the disease may be linked to decreased expression of class I HLA molecule on splenocytes and lymphocytes. The immunological factors also play a role in insulinitis. At least 85% of patients with type 1 diabetes mellitus have circulating cytoplasmic islets cell antibodies. These antibodies are directed against beta cells of the pancreas causing insulinitis and selective destruction of beta cells leading to programmed cell death (apoptosis).⁷ Some viral infections e.g. Coxsackie-B, mumps,

rubella, viral hepatitis, infectious mononucleosis may also be responsible for the causation of type 1 diabetes mellitus.^{8,9} Some environmental factors and ingested toxins may also be responsible for

Table 1: Ultrasonography of pancreas

Part of pancreas	Group 1	Group II			Total	P value
		IIA	IIB	IIC		
Head area cm ²	5.93 ± 1.59	4.83 ± 1.58	3.32 ± 1.32	1.89 ± 0.77	3.84 ± 1.76	<.05
Body area cm ²	6.66 ± 1.47	5.30 ± 2.10	2.89 ± 1.75	2.26 ± 1.18	3.99 ± 2.26	<.05
Tail area cm ²	4.00 ± 1.09	3.62 ± 1.70	2.55 ± 1.52	1.41 ± 0.51	2.89 ± 1.68	<.05
Total Pancreatic area cm ²	16.59 ± 2.49	13.75 ± 4.31	8.76 ± 3.18	5.56 ± 1.48	10.4 ± 4.61	<.001
Visualisation of pancreatic duct	0	2(13.3%)	5(50%)	5(50%)	12 (34%)	
Fibrosis and Calcification	0	0(0%)	0(0%)	3(30%)	3 (8.6%)	

insulinitis and destruction of beta cell mass. It has been suggested that exposure to cow milk or milk products early in life predisposes to autoimmune diabetes. The proposed environmental trigger is bovine albumin operating through the mechanism of molecular mimicry.¹⁰

The islets of Langerhans comprise about 1-3 % of pancreatic weight and the concentration of islets is greater in the tail than in the head and body of pancreas. Insulinitis usually involves only a few islets and persists only for a few weeks or months. The lymphocytes with a few neutrophils and macrophages are predominantly present in and around the affected islets. As the duration of diabetes increases, there is progressive and selective destruction of insulin-producing beta cells in the islets of Langerhans due to repeated inflammation. These islets become small and atrophic which ultimately leads to a small pancreatic size.

In type 1 diabetes there is widespread islet atrophy and fibrosis with associated atrophy and fibrosis in the surrounding exocrine tissue,¹¹ which can be observed after autopsy, while these changes are not seen in patients with type 2 diabetes.¹²

It has been suggested that sclerosis of islets of Langerhans with ensuing diabetes might be related to impairment of vascular supply. As the duration of the disease increases, CD₄ + T cells secrete IL1 β , tumor necrosis factor (TNF) α_1 and free radicals which are toxic to pancreatic β cells. The CD₈ + cytotoxic T cells also produce β cell autoantigen which causes β cell damage by releasing perforin and granzyme. Continued destruction of β cells eventually results in the onset of diabetes. This repeated inflammation and healing leads to fibrosis of the islets which ultimately cease to function

and is followed by dystrophic calcification of the functionless islets which may be compared to the laying down of a tombstone.¹³ The fibrosis and calcification is probably due to lack of paracrine effect of insulin. The size of the pancreas is smaller in type 1 diabetics as compared to healthy subjects because of the atrophy and fibrosis of exocrine tissue.¹⁴

Stella¹⁵ *et al* studied 30 healthy controls and 25 patients with type 1 diabetes mellitus by ultrasonography to evaluate possible volumetric alterations in the pancreas and their eventual progression over time. There was significant reduction in the area of head, body and tail of pancreas in diabetic patients. Silva¹⁶ *et al*, Sidho¹⁷ *et al*, Chiarelli¹⁸ *et al* and Altobelli¹⁹ *et al* further studied pancreatic morphology in patients with type 1 diabetes mellitus and confirmed that there is a reduction in total size of pancreas along with increased diameter of the main pancreatic duct.

In the present study the size of the pancreas was found to be significantly reduced in patients with type 1 diabetes mellitus. The reduction involved all portions of the gland (head, body and tail), and was detected in both children and adults. It was also observed that patients with type 1 diabetes mellitus of more than 5 years duration had a smaller pancreatic size, while patients with more than 10 years duration of diabetes had additional features of fibrosis and calcification. In healthy controls the pancreatic duct is not visualised or is less than 2.55 mm in diameter while in patients of type 1 diabetes mellitus it is visualised and dilated ranging from 3.1 to 7.0 mm in diameter. This dilatation was proportional to the duration of type 1 diabetes mellitus. Nephropathy, retinopathy, neuropathy and hypertension were also present in patients who had fibrosis and calcification. Renal

functions were impaired with high blood urea and serum creatinine.

Thus, it is concluded that the size of the pancreas is progressively reduced in patients with type 1 diabetes mellitus with the progressive duration of disease, and ultrasonography can be used as a non-invasive method for evaluation of the influence of disease on pancreatic size, dilatation of pancreatic duct, fibrosis and calcification.

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