DETECTION OF CEREBRAL ATROPHY IN TYPE- II DIABETES MELLITUS BY MAGNETIC RESONANCE IMAGING OF BRAIN

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Background: Diabetes is a metabolic disorder that affects many systems in the body. Cerebral atrophy is one of the complications of diabetes and research is on going to find out its aetiopathological factors**.** The main aim of the study was to determine the frequency of cerebral atrophy in type-II diabetes mellitus using magnetic resonance imaging of the brain. **Methods:** One hundred diabetic patients (Random blood sugar >126 mg/dl) were recruited in this study after the informed consent from every patient. Duration of diabetes was five years and more in all the patients as determined by their glycosylated haemoglobin which was >6 in all the patients. All the patients were undergone MRI of brain using 1.5 Tesla power magnetic resonance imaging machine of Picker Company. Evan's index, a specific parameter for measurement of cerebral atrophy was calculated on MR images and was used in this study. **Results:** In male group the frequency of cerebral atrophy was 22 (47%) and in female group it was found to be 23 (43%). When we study the overall population the frequency was found to be 45 (45%). The results are well in concordance with the previous data published on this issue. **Conclusions:** Cerebral atrophy, a complication of long standing diabetes is quite frequent in our population and is well diagnosed by MRI.

Keywords: Diabetes Mellitus, cerebral atrophy, MRI, frequency, complications of diabetes

INTRODUCTION

Cerebral atrophy is a common feature of many of the diseases that affect the brain. In brain tissue, atrophy describes a loss of neurons and the connections between them. Atrophy can be generalised, which means that all of the brain has shrunk; or it can be focal, affecting only a limited area of the brain and resulting in a decrease of the functions that area of the brain controls. If the cerebral hemispheres are affected, conscious thought and voluntary processes may be impaired as well. Cerebral atrophy is associated with symptoms like dementia, seizures, and a group of language disorders called the aphasias.

Imaging options of the nervous system encompasses a wide variety of modalities that have undergone rapid evolution in the past few decades. Plain film analysis of the skull and spine, although still employed, is not routine in the initial investigation of patients with neurological signs and symptoms. Computed Tomography (CT), developed in the 1970s, remains a common radiographic technique, particularly for the acutely traumatised patient. Magnetic resonance imaging (MRI), which came into widespread clinical usage in the 1980s, has supplanted CT for evaluation of many suspected pathological processes of the brain and spine. Depending on availability, MRI is often the initial study ordered, particularly in an outpatient setting. MRI continues to be a rapidly evolving field, encompassing techniques such as magnetic resonance angiography (MRA) and spectroscopy. Myelography, introduced in the early 1900s, has been replaced to varying degrees by MRI owing to the non-invasive nature of the latter. Positron emission tomography (PET) and single photon emission computed tomography, CT and MRI are the core imaging methods in neurodiagnosis.[1] Computed Tomography is often more accessible and less expensive, but MRI is the 'gold standard' for detecting and delineating intracranial and spinal lesions. In the past, the major advantage of CT was the speed and simplicity of imaging, which reduced patient discomfort and motion artefact. Ultrafast MR methods such as echo-planar imaging (EPI) now allow similar rapid imaging with MRI. CT technology has also advanced to allow acquisition of angiography (CTA) and dynamic physiologic imaging such as cerebral perfusion (CTP), comparable to MRA and MR perfusion-weighted imaging (PWI).[2,3] Although CT and MRI technologies are converging in some areas, there remain inherent advantages of MRI based on its sensitivity to tissue physiology and biochemistry, such as with DWI for cerebral ischemia, functional imaging (fMRI) for cerebral activation, and spectroscopy (MRS) for specific diagnosis of metabolic and neoplastic disorders.[3,4] Continued experience and advances in CT and MRI technology will likely lead to improved sensitivity and specificity of existing methods and development of unique and complementary neurodiagnostic applications in the future. The objective of the current study was to determine the frequency of cerebral atrophy in type-II diabetes mellitus using magnetic resonance imaging of the brain.

MATERIAL AND METHODS

It was a Cross-sectional study and was carried out in the Department of the Diagnostic Radiology, Holy Family Hospital, Rawalpindi. Study was completed in six months. Total 100 diabetic patients (Random blood

sugar >126 mg/dl) were recruited in the study. Consecutive sampling was made and patients having diabetes for at least five years of either sex or age groups between 50 to 60 years of age were included in the study. Patients having hypertension, psychotic disorder, transient ischemic attacks, diseases of central nervous system, those on chemotherapy, presence of metal implants, pace makers, shrapnel, claustrophobia, and with previous multiple infarcts, were excluded from the study.

Data was collected on prescribed Performa. 1.5 Tesla power magnetic resonance imaging machine of Picker Company was used for the study. This study was done by performing magnetic resonance imaging with 5 mm thickness slices in axial plane. Standard sequences used were axial T1W, axial T2W, sagittal T2, proton density and fluid attenuated inversion recovery sequence. Images were read on console and data applied and collected. The core MRI protocol included proton density and T2-weighted as well as T1-weighted sequences with 20 axial slices that were 5- or 6-mm thick with an interslice gap of 1 or 1.2 mm, respectively. Hard copies of the scans were evaluated at the radiology department of Holy Family Hospital Rawalpindi. Measurement of distance between lateral walls of both frontal horns of lateral ventricles was made in centimetres (A=cm). Measurement of distance between inner tables of skull along horizontal line passing through posterior horns of lateral ventricles just in front of choroid plexus were also made in centimetres (B=cm). Figure-1 shows how measurements were made. Evan's Index was then calculated as a ratio of A is to C (A/C).

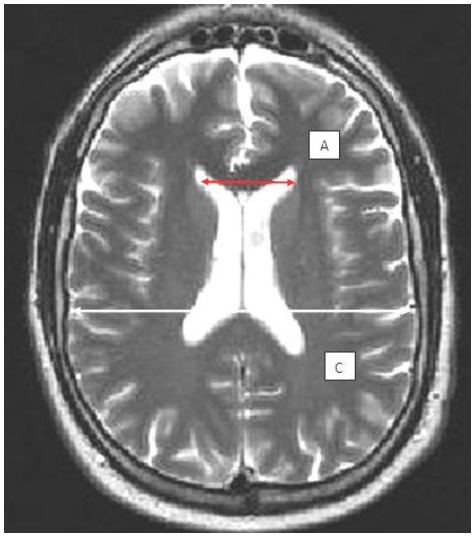

Figure-1: Measurements for Evans index

Data was analysed using SPSS-10. Mean and standard deviation were calculated for numerical variables, i.e., age. Frequency and percentage were presented for categorical variables, i.e., gender, Evan's index. Chi-square test was used for testing the significance of results.

RESULTS

One-hundred (100) diabetic patients (Random blood sugar >126 mg/dl) were recruited in this study. Duration of diabetes was five years and more in all the patients as determined by their glycosylated haemoglobin which was >6 in all the patients. Forty-seven patients were male with age 55.7±3.06 years and 53 were female with age 55.09±3.57 years. Cumulative age was 55.39±3.34 years. Demographic results are shown in Table-1. Evan's index was measured through MRI imaging and a cut-off of 0.3 was used as a determinant of cerebral atrophy. Subjects having Evan's index value >0.3 were labelled as having cerebral atrophy. Our study results showed that in male group the frequency of cerebral atrophy was 22/47 (47%) and in female group it was found to be 23/53 (43%). When we study the overall population the frequency was found to be 45 (45%), (Table-2).

The One Sample Kolmogorov-Smirnov Test (1-Sample K-S) was applied on both male and female groups using SPSS 10.0 to compare the cumulative distribution function of the data collected to a theoretical cumulative distribution. As the data was continuous numeric the normal distribution was assumed. Parameters of the theoretical distribution were estimated from the observed data. Absolute indicates the largest absolute difference between the theoretical cumulative distribution and the observed cumulative distribution function. Large *p*-values (>0.05) indicate that the observed distribution corresponds to the theoretical distribution. In our data the *p*-value exceeded 0.05 in both the groups. Thus the distribution of values of Evan's Index in both groups resembles a normal distribution, (Table-3).

Runs Test was applied on the data which showed large *p*-values suggesting that both data were randomly ordered.

Table-1, 2 and 3 display the number and percentage of cases for each value of the variable. Figure-3a & b show the relative distribution of the frequencies in male and female group respectively. Our study showed that the *p*-value was 0.635 for male group and 0.347 for female group. Thus, our Null Hypothesis was rejected and the alternative hypothesis stated, 'Observed distribution of frequencies conform to the expected distribution of frequencies' was accepted.

Table-1: Demographic profile of the study population

Gender	Number	Age (Years) Mean±SD
Male	47	55.72±3.06
Female	53	55.09±3.57
Total	100	55.39±3.34

Table-2: Frequency and percentage of cerebral atrophy in our study

Gender	No	Percentage
Male	22	43
Female	23	47

Table-3: Statistics of 1-sample K-s test on both groups

	Male	Female
Number (n)	47	53
Mean	0.2989	0.2945
SD	6.109	5.767
p-value	0.701	0.565

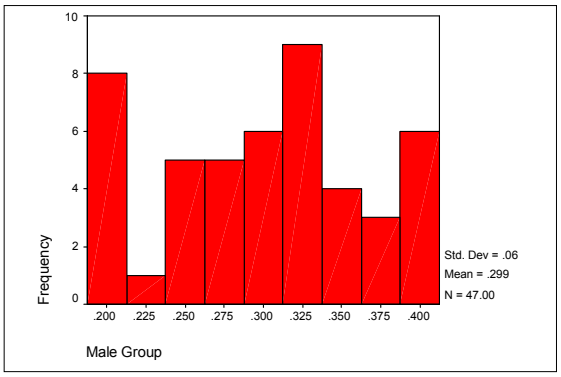

Figure-3a: Relative Distribution of frequencies in male group

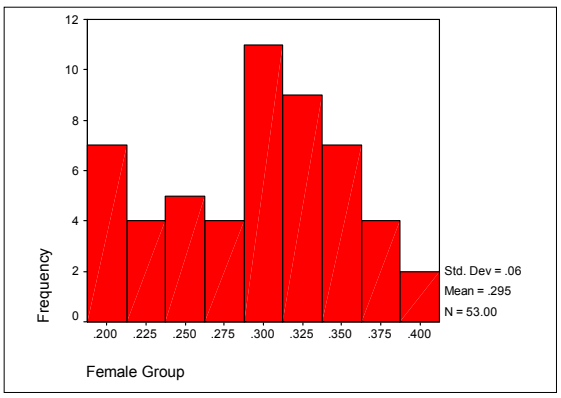

Figure-3b: Relative Distribution of frequencies in Female group

DISCUSSION

Diabetes is a metabolic disorder that affects many systems in the body. Previous radiological studies of patients with diabetes were based on highly selective groups of individuals referred to computed tomography or magnetic resonance imaging (MRI) neuroimaging.[5–19] Only a few population-based studies assessed the association of diabetes–as one of many cardiovascular disease (CVD) risk factors–to only one specific type of brain lesion.[20–24] The reported results are inconsistent. Only 6[7,8,10,13,18,22] of 19 investigations[5–23] found diabetes to be a risk factor for small vessel disease–related brain abnormalities, including white matter lesions or lacunes. Three studies found associations with cerebral atrophy.[5,9,23] In the present study we determined the frequency of cerebral atrophy in diabetic patients along with other associated lesions.

Of the 100 study participants with diabetes, 47 subjects were male and 53 were female. Our study results showed that in male group the frequency of cerebral atrophy was 23 (47%) and in female group it was found to be 22 (43%). When we study the overall population the frequency was found to be 45 (45%). There are at least three possible explanations for cerebral atrophy in individuals with type II diabetes. One hypothesis suggests that because diabetics are prone to blood vessel pathology, they may have small strokes that cause the brain to shrink over time. Although the MRI studies show some evidence of small stokes in these patients, they also indicate that this factor does not play a major role in the atrophy as only 20% of patients have changes that look like small strokes on MRI. A second possible explanation holds that poor control of brain glucose may lead to chemical changes--and ultimately neuronal loss--similar to the changes seen in Alzheimer's disease patients. But many if not all patients in the study use state-of-the-art insulin pumps and maintain very good glycaemic control. Still, their glycaemic control may have been worse in earlier years. The older subjects are among the first generation of type 1 diabetics treated with insulin, and methods for maintaining fine glycaemic control are fairly recent. A third hypothesis suggests that diabetes heightens the body's immunologic status. This could cause a chronic, low-grade inflammation that damages brain cells.

Our results are in concordance with the other studies. Robert Fin *et al*[26] has conducted an MRI study of young, otherwise healthy individuals with type 1 diabetes. The study revealed significant cerebral atrophy, nearly 90% of individuals with type-1 diabetes in the study had brain-volume scores lower than the 50th percentile of nondiabetic subjects, according to interim results from 26 diabetic and 24 nondiabetic subjects. Despite the relatively small number of subjects, the brain-volume difference proved to be highly statistically significant. Cerebral atrophy is common in young persons with juvenile-onset diabetes, and there is evidence that small blood vessels within the brain's white matter are damaged in these patients, neurologists at the University at Buffalo and the University of Western Ontario have found.

Another study[27] showed results quite similar to that of ours. There were 26 diabetic and 24 non-diabetic persons in the cerebral-atrophy study, and 33 diabetic and 20 non-diabetic participants in the white-

matter-lesion study. All participants were between the ages of 18 and 50. Diabetics were diagnosed before the age of 18 and had the disease for 10 years or more. The same study population was used for both investigations. About half of the participants were enrolled through UB, the lead institution, and half through the University of Western Ontario. Results showed that 23 of the diabetics, or 88.5 percent, had brain volumes lower than the median for control subjects.

CONCLUSION

Cerebral atrophy, a complication of long standing diabetes is quite frequent in our population. It is associated with other brain lesions and is well diagnosed by morphological imaging like magnetic resonance imaging (MRI).

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