THE EFFECT OF DIABETES MELLITUS ON THE KIDNEY, AN ULTRASONOGRAPHIC STUDY

THESIS

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By

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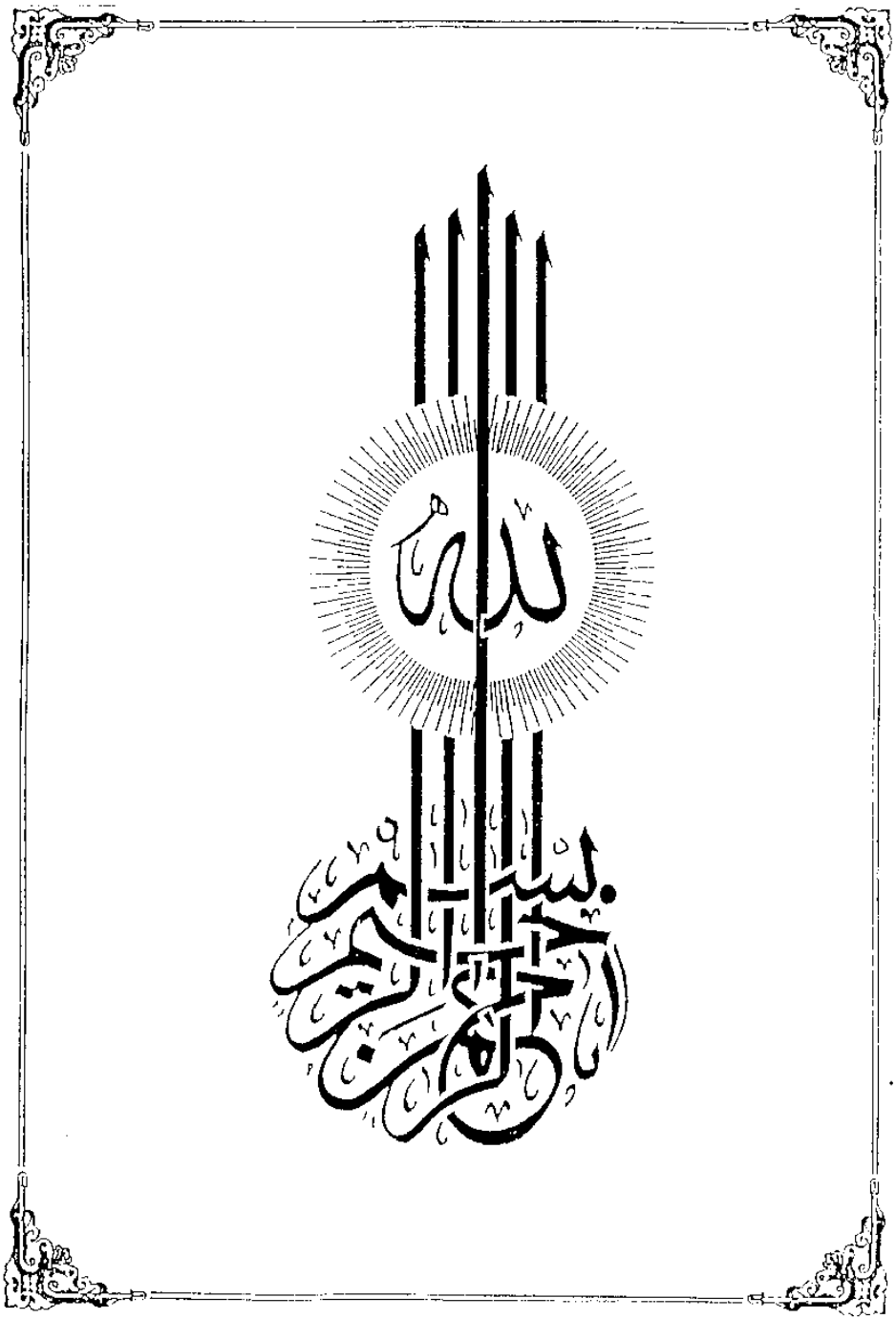

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I N T R O D U C T I O N

INTRODUCTION

Diabetes was for many centuries regarded as a disease of the kidneys. This was the opinion of Aretaeus the Cappadocian in the second century A.D. and was still held by Erasmus Darwin in 1801. The presence of proteinuria in diabetes has long been known. Vacuolization of the tubular epithelium was observed by Armanni (1875) and Ebstein (1881) and was shown to be due to glycogen infiltration (Ehrlich 1883). Kimmelsteil and Wilson (1936) were the first to attribute specific glomerular lesions to diabetes when they described the spherical hyaline masses now known by their names. The diffuse lesion was demonstrated soon afterwards by Fahr (1942) and arteriolar lesions were described by Bell (1942). In 1953 Lundbaek described glomerulosclerosis as one of the manifestations of a more generalized microangiopathy. (Black, S.D., and Jones, M.P. 1979).

Diabetic nephropathy accounts for about 5.7% of all deaths among patients with diabetes and 20% among diabetic patients below the age of 45. In addition, other renal diseases commonly associated with diabetes, such as pyelonephritis, renal arteriolosclerosis, and papillary necrosis account for at least an additional 9% of diabetic-related deaths.

When progressive renal impairment occurs in diabetic patients, there are changes in insulin requirement, owing to

changes in both excretion and metabolism of insulin. Additionally, uremic patients without overt diabetes mellitus may develop alterations of lipid and carbohydrate metabolism: these changes constitute a syndrome which is often referred to as the "pseudodiabetes of uremia" (Allen, I.A. 1976).

Renal affection is an almost invariable concomitant of diabetes, and the definition of diabetes mellitus, in addition to insulin insufficiency and its associated metabolic disorders includes concomitant premature vascular degeneration as an integral part of the clinical picture. These two manifestations develop at different velocities so that insulin insufficiency precedes in juvenile diabetics while adult diabetic patients may exhibit any or all of the concomitants before the onset of any chemical abnormality is expressed clinically. (Churg, J. and Dolger, H. 1971).

Dolger found albuminuria and hypertension in 50% of all juvenile diabetic patients with retinopathy - all the three findings appearing within an average of 13 years after the onset of diabetes. This period was shortened in the older diabetic patients in whom, of course, the intial picture was often asymptomatic. (Dolger, H. 1947).

Fanconi in 1971 reported that 87 juvenile diabetic patients all had nephropathy within 16 years of the onset

[illegible] uremia as the most frequent cause of death. ([illegible], [illegible] et al 1971).

Ultrasonic Examination of The Urinary Tract

Physical Background and examination techniques:-

Abdominal diagnostic ultrasound utilizes high frequency sound waves usually 1.6 - 3.5 million cycles per second (1.6-3.5 MHz), to produce images of organs within the body. A transducer - a combination sound generator and sound receiver is used to direct a narrow sound beam into the body. As the sound beam passes through tissue interfaces of differing densities and elastic properties, part of the sound is reflected (echoed) at such interfaces back to the transducer. The amount of sound reflected at an acoustic interface is proportionate to the differences in density and elasticity of the two media composing the interface and is also proportionate to the acuteness of the angle at which the sound beam encounters the interface. In "A" mode ultrasound, these echoes are presented as peak deviations from a zero voltage baseline on an oscilloscope. In "B" scanning, these echoes are converted into electrical currents and transformed into dots on an oscilloscope screen that correspond to the position of the transducer on the body. "B" mode scanning is the more generally used method of ultrasound presentation for urologic tracts examinations because the resultant dot pictures more clearly resemble body

[illegible] echoes.

In gray scale presentation, brite echoes show as a very dots, and darker echoes are presented as lighter dots. The dots may be white on a black background or black on a white background. Echoes of intermediate intensity are presented as part of a spectrum of gray. Improvements in ultrasonographic techniques have resulted in the production of organ images of much higher resolution and clarity than was before. Where as a few years ago 2 centimeters was the smallest size that could be demonstrated, today objects 2 millimeters in size may be shown. (Granville, C.C. 1978).

Real Time Imaging

Real time imaging originated with the advent of "compounding" to add new information to the scan. Such a unit was built by Holmes and his group at the University of Colorado to produce compound scanning in 1968. (Holmes, J. 1974).

A small motor was used to rock the transducer 5 times [illegible] second back and forth in the patient's skin. (Sanders, R.C. 1979).

Griffith and Henry in 1974, developed a mechanical scanner which oscillates a standard transducer through either a 30 or 45° sector with a display frame rate of 30/sec. The

quality of the image obtained was considerably better than the multielement systems at this time. (Griffith, J.M. and Henry, M.L. 1979).

Other units have been developed but probably the most sophisticated is the phased-array principle developed by Thurstone and von Ramm (1974). This technique employs multiple elements in the transducer, fired in a rather complicated sequence by a computer, to sweep electronically through a sector. (Thurstone, F.L., and Ramm, V.O.T. 1976).

Real-time scanners are classified either as mechanical or electrical. The mechanical scanners have transducers which are either fixed (rotating mirror)or moved in some fashion. The electronic scanners use multiple transducers which are fired in a linear or phased-array fashion. These more sophisticated systems provide better resolution but also are more expensive (Kossoff, G., and Sanders, R.C. 1979).

The Ultrasonic Characteristics of The Renal Pelvicalyceal Echo Complex.

The pelvicalyceal echo complex was a characteristic appearance as an echo-filled cylinder in which minimal echogenecity may normally be seen. The renal pelvicalyceal echo complex originates from the medullary hilar structures consisting of the individual calyces, infundibula, hilar vessels, and renal pelvis. When a slightly oblique longitudinal

section is obtained through the middle portion of the kidney the central echo complex may be seen occupying the central two-thirds to three-fourths of the kidney. It is surrounded by a symmetrical rim of parenchyma. On longitudinal views, a cross-section of the cylinder is seen which appears as a relatively homogeneous core of echoes located in the anterior medial portion of the "C shaped" renal parenchyma. Close analysis reveals small projections at the periphery of the pelvicalyceal echo complex which represent echoes originating from individual calyces. (Sanders, R.C., and Conrad, M.R., 1977).

Uses of Ultrasound in Kidney

Kidney length can be determined accurately, also renal parenchyma can be distinguished from urine collecting spaces by the echoes.

The diagnosis of an absent kidney needs cystoscopic proof, but an ultrasound scan showing an empty loin on one side is valuable preliminary support. (Sherwood, T. et al., 1980).

Alteration in the pelvicalyceal echo complex is a helpfull guide in the diagnosis of a variety of pathological processes involving the kidneys such as hydronephrosis which appears as uniformly sized, nonvibrant collections

in the pelvicalyceal echo complex with loss communication with the renal pelvis. A minor simple renal cyst produces a sharply outlined crescentic shaped deformity of the pelvicalyceal echo complex, and hydronephrosis is seen with multiple impinging renal cysts. Focal deformity of the central echo complex is seen with polycystic kidney disease, as well as in neoplasia. Oedema and infiltrating hypernephroma may result in diminution of the pelvicalyceal echo complex. Amputation or a "V" shaped splitting of the pelvicalyceal echo complex may be seen with neoplasia. (Sanders, R.C., and Conrad, M.R., 1977).

AIM OF THE WORK

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Diabetes mellitus affects the kidneys by many complications, the aim of this work is to see if the effects of diabetes on the kidneys could be seen by ultrasonography and to see if these changes are related to the duration of diabetes or to urinary infection or neither.