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Effect of diabetes mellitus on glomerular filtration rate in an urban hospital diabetic population

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Summary

Glomerular filtration rate (GFR) as assessed by endogeneous creatinine clearance was studied in 46 male and 38 female patients with diabetes mellitus (DM). Of these, 44 patients had uncomplicated DM (Group I) whilst 40 patients had complicated DM (Group II). There were 20 insulin-dependent diabetes mellitus (IDDM) patients in Group I and 5 in Group II, and 24 non-insulin dependent diabetes mellitus (NIDDM) patients in Group I and 35 in group II. In Group I, 6 IDDM and 4 NIDDM patients had supranormal glomerular filtration rate (creatinine clearance 125 ml/min) and in Group II 1 IDDM and 6 NDDM patients had supranormal GFR. The presence of diabetic complications and the mode of therapy of the diabetic state did not significantly affect the glomerular filtration rate. This concludes that glomerular hyperfiltration occurred in both IDDM and NIDDM Nigerian patients.

Résumé

Le taux de filtration glomerulaire évalué par la disparition de creatinine endogène a été étudié chez des patients (46 males, 38 femmelles soufrant de diabète mellitus (DM). De ceux-ci, 44 patients, avaient un DM sans complication (Groupe I). Cependant, 40 patients présentaient un DM à complication (DM plus DM à complication) (Groupe II). Il y'avait 20 et 5 cas de diabètes mellitus insulino-dependant (IDDM) dans les groupes I et II respectivement, 24 et 35 cas de diabètes mellitus non insulino-dépendant (NIDDM) dans les groupes et II respectivement. Dans le groupe I, 6 patients à IDDM et 4 patients à NIDDM ont présenté un taux de filtration glomerulaire (GRF) supranormal (disparition de la creatinine 125 ml/min), dans le groupe II un patient à IDDM et 6 à NIDDM ont eut une taux de filtration glomerulaire supranormal. La presence du diabète à complication et le mode therapy de l'état diabétique n'a pas affecté significatifement le taux de filtration glomerulaire. Nous concluons que l'hyperfiltration glomerulaire se produit chez les patients Nigerians souffrant soit de IDDM ou de NIDDM.

Introduction

Diabetes mellitus is the most common endocrine disease and one of its usual complications is diabetic nephropathy which is usually heralded by glomerular hyperfiltration. In Nigeria, the true incidence of diabetes mellitus has not been ascertained, but in the Lagos metropolis, the prevalence rates of undiscovered diabetes mellitus were 1.5% in males and 1.9% in females [1]. Elevated glomerular filtration rate has been observed over decades in both clinical and experimental diabetes [2-5] and approximately one third of patients with insulin dependent diabetes mellitus will display a glomerular filtration rate outside normal range [2]. As glomerular hyperfiltration is one of the factors responsible for the development of diabetic nephropathy [6], it was pertinent to investigate the effect of diabetes mellitus on glomerular filtration in an urban hospital population where the disease is common and where chronic renal failure is prevalent.

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Subjects and methods

In this study, the age of onset (35 years) and insulin dependence and insulin independence were criteria used for insulin dependent mellitus (IDDM) and non-independent diabetes mellitus (NIDDM), respectively. All the patients were admitted into the medical wards of the Lagos University Teaching Hospital. The features, including complications necessitating admission were polydypsia, polyphagia, polyaria, weight loss, diabetic ketoacidosis, leg ulcer, gangrene, and cataract. Patients with overt diabetic nephropathy or clinical proteinuria were excluded from the study.

The patients were grouped into two. Group I comprised 44 patients with uncomplicated diabetes mellitus and Group II comprised 40 patients with complicated diabetes mellitus. At the time of the study, 49 patients were on insulin, 21 patients were on insulin plus oral hypoglycaemic agent (OHA - glibenclamide and chlorpropamide), and 14 patients were on OHA and/or a diabetic diet. When the diabetic state was considered stable, as reflected by 2-hour post-prandial venous blood glucose of < 10.0 mmol (< 180 mg per dl), creatinine clearance was assessed in each patient. Twenty-four hour timed urine and venous blood samples obtained by venepuncture before the end of urine collection were collected from each patient. Attempts to collect the urine and blood in duplicate were fraught with many problems such as incomplete collection of urine or falsification, and the attempts had to be abandoned. Any urine sample of less than 500 ml was discarded,

The creatinine concentration in the urine and blood samples was estimated by the alkaline picric acid method: the urine volumes were measured and clearances calculated using the formula:

$$\frac{UV}{P} = \frac{\text{Urine creatinine mg \%}}{\text{Plasma creatinine mg \%}} \times \text{volume of urine (ml/m)}$$

Creatinine clearance > 125 ml/min^{-1} was taken as supranormal clearance (Ccr) [4]. For statistical analysis, student's t test and the chi square were used to compare differences and $P < 0.05$ was chosen as the level of significance.

Results

Mean Ccr 96.2 (sd ± 52.2) ml/min in IDDM group I male patients and mean Cr 80.0 (sd ± 72.8) ml/min in IDDM group II male patients are not statistically different ($P > 0.05$). Mean Ccr 82.4 ± 29.7 (sd ± 72.8) ml/min in IDDM Group I female patients and mean Ccr 64.0 (sd ± 14.1) ml/min in IDDM Group II female patients are not statistically different ($P > 0.2$) Table 1.

Mean Ccr 68.4 (sd ± 45.4) ml/min in NIDDM Group I male patients and mean Ccr 78.0 (sd ± 48.8) ml/min in NIDDM group II male patients are not significantly different ($P < 0.05$). Mean Ccr 72.4 (sd ± 40.0) ml/min in NIDDM group I female patients and mean Ccr 74.2 (sd ± 35.6) ml/min in NIDDM group II female patients are not significantly different ($P < 00.5$) Table 2.

The proportion of patients with supranormal Ccr was similar in all groups (Table 3). There was no statistically significant difference ($P > 0.5$) between the mean Ccr of the patients on insulin, insulin plus oral hypoglycaemic agent, or oral hypoglycaemic agent plus diet in patients with and without supranormal creatinine clearance.

Figure I shows scattergram of Ccr in Group I and II IDDM and NIDDM patients.

Table 1: Creatinine clearance in IDDM patients: Group I DM only Group II (DM + DM complications)

	Group I Male	Group II Male	Group I Female	Group II Female
Number	13	3	7	2
Age range (years)	17-46	26-37	15-34	22-34
Mean ± sd (years)	29.4 (± 8.5) NS	33.3 (± 6.4)	24.0 (± 7.9)	28.0(± 8.5)
Duration of DM Mean ± sd (years)	5.0(± 4.3) NS	6.3(± 1.5)	5.2 (± 4.5)	3.5(± 3.5)
Ccr range ml min^{-1}	54.0 -182.0	35.0 - 164.0	56.0 ± 144.0	54.0 ± 74.0
Ccr mean ± sd ml min^{-1}	96.2(± 52.2)	80.0 (± 72.8)	82.4 (± 29.7)	64.0 (± 14.1)

NS=Not significant

Table 2: Creatinine clearance in NIDDM patients — Group I (DM only) Group II (OM only) Group II (Dm + Dm complications)

	Group I Male	Group II Male	Group I Female	Group II Female
Number	10	20	15	14
Age range (years)	46-67	40-70	45-69	43-70
Mean age ± sd (years)	54.5 ± 8.6	55.2 ± 9.8	54.4 ± 7.2	56.7 ± 9.9
Duration of DM Mean ± sd (years)	7.0 ± 5.7	9.7 ± 8.3	5.1 ± 4.3	6.2 ± 3.6
Ccr range ml min^{-1}	19-61	21-182	29-155	25-149
Mean Ccr ± ssd ml min^{-1}	68.4 ± 45.4	78.0 ± 48.8	72.4 ± 40.0	74.2 ± 35.6

Table 3: Number of patients with and without supranormal clearance

	IDDM Group I Number	NIDDM Group I Number	IDDM Group II Number	IDDM Group II Number
Observed supranormal clearance	6	4	1	6
Expected supranormal clearance	4	5	1	7
Observed non supranormal clearance	14	21	4	28
Expected non supranormal clearance	16 1.25	200.25	4 -	27 0.14

Table 4: Mode of therapy and creatinine clearance (Ccr) in all patients

	Insulin only A	Insulin + oral Hypoglycaemic Agent (OHA) B	OHA + Diet C
Ccr 125 ml/min Number of patients	11	4	2
Mean age s years	40.2 (± 19.5)	47.8 (± 9.6)	53.5 (± 7.8)
Mean Ccr sd ml/min	156.2 (± 16.6) A/B	160.5 (± 12.67) A/C	140.0 (± 12.7) A/C
Ccr 125 ml/min^{-1} Number of patients	38	17	12
Mean age sd	45.8 (± 16.8)	46.8 (± 12.7)	60.3 (± 6.1)
Mean Ccr sd ml/min	64.2 (± 31.8) A/B NS	65.3 (± 28.9) B/C NS	60.3 (± 20.8) A/C NS

NS= Not significant

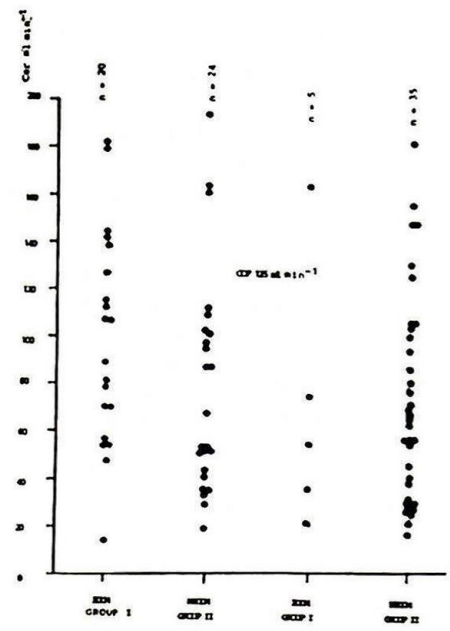

Fig. I

Discussion

Renal complication is a leading cause of death and morbidity in diabetes mellitus. Approximately 20-50 % of patients with IDDM develop this complication, but the prevalence is somewhat less in the non-insulin dependent form of the disease [2]. Though glomerular hyperfiltration is a well recognized feature of IDDM [7,8], the occurrence in NIDDM has been questioned by some authors [9,10] whilst other authors [11,12,13] have reported such phenomenon. Silveiro *et al.* [13] reported glomerular hyperfiltration in 21 % of their NIDDM patients without overt proteinuria. In this study we observed glomerular hyperfiltration without clinical proteinuria in similar percentage (20.4%) of NIDDM patients whilst 28.9% of our IDDM patients exhibited glomerular hyperfiltration. Proteinuria alone might not predict renal functional changes in diabetic patients as progressive decline in renal function has been reported in both type I and type II diabetic patients with and without proteinuria [14].

The mechanism for glomerular hyperfiltration has generated a lot of controversy. Many factors [15] have been advanced including insulin, growth hormone, hyperglycaemia, and a liver hormone. In this study we have not been able to show the mechanism for hyperfiltration observed. There was no statistically significant difference in the mean creatinine clearance in patients on insulin, insulin plus oral hypoglycaemic agent, or hypoglycaemic plus diet.

In conclusion, in a study of the effect of diabetes mellitus on glomerular filtration rate we observed glomerular hyperfiltration in both insulin and non-insulin dependent diabetic patients in an urban hospital in Nigeria.

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References

1. Ohwovoriole AE, Kuti JA, Kabiawu SIO. Casual blood sugar levels and prevalence of undiscovered diabetes mellitus in Lagos Metropolis, Nigeria. Dia Res Clin Prac 1988; 4: 153-158.
2. Hostetter TH. Diabetic nephropathy. In Brenner and Rector, eds. The Kidney, fourth edition 1991; 2: 1695-1727.
3. Mogensen CE, Osterby R, Gundersen HJG. Early functional and morphologic vascular renal consequences of diabetic state. Diabetologia 1979; 17: 71-76.

4. Mogensen CE. Elevated glomerular filtration rate in Insulin treated short term diabetes non-dependence of the actual blood sugar level. Acta Med Scand 1973; 194: 559- 561.
5. Hostetter TH, Tray JL, Brenner BM. Glomerular haemodynamics in experimental diabetes mellitus. Kidney Int 1981; 19:410-415.
6. Mongesen CE. Blood pressure, renal haemodynamics and albumen excretion as predictors for diabetic nephropathy Diab Nephrol 1985; 4: 30-31.
7. Dietzel J, Schwartz N. Abnormally increased glomerular filtration rate in short-term insulin treated subjects Diabet 1967; 16: 264-267.
8. Mogensen CE. Glomerular filtration rate and renal plasma flow in long term juvenile diabetics without proteinuria Bri Med J 1972; 2: 257-59.
9. Friedman EA, Sheih SD, Hirsch SR, Bashell BE. Supranormal glomerula filtration (GFR) in type II (non-insulin dependent) diabetes (Abstract) Am So Nephrol 1981; 14: 102A.
10. Fabee J, Balant LP, Dayer PG, Fox HM, Vernet AT. The kidney in maturity onset diabetes mellitus. A clinical study of 510 patients. Kidney Int 1982; 21: 730-738.
11. Schmitz A, Hensen HH, Chritensen T. Kidney function in newly diagnosed type 2 (non-insulin dependent) diabetic patient before and during treatment. Diabetologia 1989; 32: 434-439.
12. Labovitz H, Palmisano J. Cross sectional analysis of renal function in Black Americans with NIDDM. Diabetes Care 1990; 13: (suppl. 4): 1186-1190.
13. Silveiro SP, Friedam R, Gross JL. Glomerular hyperfiltration in NIDDM patients without overt proteinuria. Diabetes Care 1993; 16(1): 115- 119.
14. Tsalemandri C, Allen TJ, Gilbert RE, Sinha A, Panagiotopoulos S, Cooper ME, Jerum G. Progressive decline in renal function diabetic patients with and without albuminuria. Diabetes 1994; 43: 649-655.
15. Alvestrand A, Bergstrom J. Glomerular hyperfiltration after protein ingestion during glycagon infusion, and in insulin independent diabetes is induced by a liver hormone Lancet 1984; 1:195-197.