Studies on maturity onset diabetes of the young (MODY) from S. India

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ABSTRACT

We examined the following aspects of Maturity Onset Diabetes of the Young (MODY): prevalence, vascular complications, insulin secretion in offspring of MODY subjects, insulin resistance and whether MODY can be considered a distinct disease.

We report a higher prevalence of MODY among Asian Indian patients. The prevalence rates of microvascular complications in MODY were found to be the same as in classical NIDDM patients. Glucose stimulated insulin and C-peptide responses were compared with non-diabetic controls. In MODY subjects, C-peptide responses were lower, whereas insulin responses were varied. Insulin secretion in offspring of MODY subjects was similarly evaluated, and abnormalities discovered even in these pre-diabetic subjects. Using the euglycaemic clamp technique, MODY patients were found to be more insulin resistant than classical NIDDM patients. Further lines of evidence are needed to resolve whether MODY can be considered a distinct disease.

INTRODUCTION

The entity known as Maturity Onset Diabetes of the Young (MODY) was first described by Fajans (1) who first reported youth onset diabetics who were not dependent on insulin. Later Tattersall (2) from the king's College, London, published a report entitled "Mild familial diabetes with dominant inheritance" where he described non-insulin-dependent diabetes presenting in youth. Soon a joint report followed from Tattersall and Fajans (3) where the term "MODY" was used for the first time using the first letters of "Maturity Onset Diabetes of Youth." In this paper they set down the following criteria for the diagnosis of MODY:

1. Age at diagnosis below 25 years
2. Control of fasting hyperglycaemia without insulin for a minimum of 2 years and
3. Absence of ketosis at any time

Tattersall has recently suggested that the period without insulin should be extended to 5 years to completely exclude cases of IDDM who might initially respond to oral agents (4). It has also been suggested (4) that autosomal dominant inheritance should be used as a diagnostic criterion. However most studies in the literature have used the original criteria of Tattersall and Fajans.

PREVALENCE OF MODY

A number of reports from Europe and U.S.A. (5-8) have confirmed the existence of MODY. However, MODY is not a common form of diabetes among the while population (8). Recently it has been recognised that in certain communities of the world MODY type of diabetes is more common. This has been shown in Pima Indians (9), in the Nauru population (10) and more recently in Asian Indians in South Africa (11) and southern India (12).

The actual prevalence of MODY in different populations still remains unknown. The only study that has examined the prevalence of MODY in the general population (8) found it to be 0.15%. In Tattersall's original report (2), 1 in 200 patients attending the King's College Hospital were found to have MODY type diabetes. In S. Africa, Jialal and co-workers (11) using a cut-off point of 35 years, found that 10% of Indian NIDDM patients had MODY, a figure that was very much higher than in black and white communities living in S. Africa. In southern India we (12) found that 4.8% of our NIDDM patients at Madras had age at diagnosis below 25 years, in 18.5% it was below 35 years and in almost 50% it was below 45 years. Thus, there appears to be a higher prevalence of MODY among Asian Indian patients.

VASCULAR COMPLICATIONS IN MODY

There is considerable controversy whether patients with MODY are prone to vascular complications. Tattersall (2) in his original report stated that microvascular complications were very uncommon in MODY.

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Based on a large series, Fajans (13) reported that vascular complications occurred in his MODY patients with the same frequency as in classical NIDDM patients. Tattersall (4) then suggested that there could be different subgroups within MODY, such as autosomal dominant MODY and sporadic MODY and that the dominantly inherited MODY were protected from microvascular complications.

During the last 6 years, several reports on microvascular complications in Asian Indian MODY patients have been published and these have been recently reviewed (14-16). At the Diabetes Research Centre, Madras, were registered a very large series of MODY patients (219 patients). This afforded a good opportunity to test the hypothesis that patients of MODY are protected from microvascular complications. We divided our 219 patients into three groups: MODY with definite autosomal dominant inheritance which included vertical transmission of diabetes through three or more generations; MODY patients who had a first degree relative with diabetes but in whom the dominant inheritance was not definite and finally a group of MODY with no family history of diabetes; sporadic or non-hereditary MODY.

Table 1 shows the occurrence of vascular complications in the three subgroups of MODY. It can be seen that microvascular complications were equally common in all three subgroups of MODY including those with autosomal dominant inheritance (12). In a more recent study (17) we looked at vascular complications in 85 MODY patients who were watched for duration of diabetes with a group of classical NIDDM patients. It was found that there was no significant difference between the MODY and the classical NIDDM patients in prevalence rates of microvascular complications. Macrovascular complications, on the other hand, were less common among the MODY patients but this is hardly surprising considering their younger age. We therefore concluded that MODY were prone to microvascular complications just like the patients with classical NIDDM. Similar findings have been reported by Jialal et al from S. Africa (18).

INSULIN SECRETION IN MODY

Considerable heterogeneity has been described with respect to insulin responses to an oral glucose load in MODY (13). Thus families with normal as well as high insulin responses to glucose load have been described. Since it is known that approximately 50% of insulin undergoes extraction in the liver whereas the extraction of C-peptide is negligible, C-peptide assay gives us a better index of pancreatic beta cell secretion and simultaneous assay of insulin and C-peptide gives information regarding pancreatic beta cell secretion as well as the peripheral

Table 1. Percentage distribution of vascular complications in MODY*

	< 15 yr duration			> 15 yr duration		
	Definite autosomal dominant MODY (n=43)	Possible autosomal dominant MODY (n=82)	Non-hereditary MODY (n=34)	Definite autosomal dominant MODY (n=16)	Possible autosomal dominant MODY (n=35)	Non-hereditary MODY (n=9)
BDR	2	11	6	25	41	44
Proliferative retinopathy	2	2	3	6	6	11
Nephropathy	7	5	6	6	23	33
Neuropathy	2	12	6	31	49	55
IHD	0	4	0	6	14	0

*Ref 12-Mohan et al. Diabetes Care 1985; 8: 371-74.
BDR = Background Diabetic Retinopathy
IHD = Ischemic Heart Disease;
Difference between the three groups of MODY: not significant (Fischer's exact probability test)

metabolism of insulin. We therefore performed simultaneous studies of insulin and C-peptide responses to glucose load in subjects with MODY and matched groups of control non-diabetic subjects. We found that C-peptide responses to glucose load were lower in MODY subjects, thereby providing evidence for decreased beta cell function in MODY (19). The insulin responses were varied, with some patients having normal responses and others low responses. This suggests that there could be an additional defect in the peripheral metabolism of insulin, most likely at the hepatic level. This could be a compensatory mechanism to maintain higher physiological circulating levels of insulin in the face of defective pancreatic beta cell function. Recent studies from S. Africa (20, 21) have confirmed our observations regarding defective beta cell secretion in MODY.

INSULIN SECRETION IN OFFSPRING OF MODY SUBJECTS

Having established that defective pancreatic beta cell secretion is a feature of MODY patients, our next objective was to see whether this defect in beta cell secretion precedes the onset of diabetes and if so, whether this could be used as an early biochemical marker for diabetes in MODY families. This is particularly relevant because in a disease with autosomal dominant inheritance only 50% of the offspring eventually develop diabetes if only one of the parents has the disease. It would therefore be useful if an early biochemical marker for diabetes could be found in these families.

We studied offspring of MODY subjects (O-MODY) at a stage when they had normal glucose tolerance tests and examined their insulin and C-peptide responses to a glucose load. We were able to find evidence of abnormalities of insulin secretion even in these prediabetic subjects, suggesting that biochemical defects in MODY may be identifiable years before the onset of clinical diabetes.

INSULIN RESISTANCE IN MODY

Earlier studies on insulin resistance in MODY have produced conflicting results (23, 24). The euglycaemic clamp technique is widely recognised as one of the best ways of assessing insulin resistance (25). Mohan et al (26) performed euglycaemic clamps in MODY patients and healthy non-diabetic control subjects. The results showed that despite their younger age, MODY patients were more insulin resistant than classical NIDDM patients. It was therefore concluded that insulin resistance is a feature of MODY patients and this could be one of the factors responsible for the younger age at onset of diabetes that was observed in them.

IS MODY A DISTINCT DISEASE?

There are several lines of evidence to suggest that MODY is a distinct disease. Firstly MODY is the only form of diabetes today where a definite mode of inheritnace has been worked out (27). It is also the only type of diabetes for which a monogenic inheritance has been proposed. The prevalence of MODY varies in different ethnic groups. This is also suggestive of a distinct disease that has varying prevalence rates in different communities.

There is also evidence to suggest that MODY could be just one end of the spectrum of NIDDM. The clinical features of MODY and the biochemical and hormonal characteristics do not show any differences from classical NIDDM. Genetic studies on MODY (10, 28) have drawn a blank so far, though admittedly these have been done on Caucasian subjects MODY. Very recently, in collaboration with Dr. Graham Hitman of the Royal London Hospital, Whitechapel, London, we (29) have looked at various gene markers in MODY. The results showed that there was a strong association with the class 3 allele of the insulin gene but the results were not different from that seen in classical NIDDM patients. Obviously more studies need to be done to resolve whether MODY is a separate disease or merely a continuum of NIDDM.

REFERENCES

1. Fajans SS , Conn JW. Prediabetes, subclinical diabetes and latent clinical diabetes: interpretation, diagnosis and treatment. In: On the nature and treatment of diabetes. Leibel BS, Wrenshall, eds. New York: Excerpta Media Int. Congr. Series No. 84, Excerpta Media, 1965: 641-56.

2. Tattersall RB. Mild familial diabetes with dominant inheritance. Q J Med 1974; 43: 339-57.

3. Tattersall RB, Fajans SS . A difference between the inheritance of classical juvenile onset and maturity onset type diabetes of young people. Diabetes 1975; 24: 44-53.

4. Tattersall RB. The present status of maturity onset type of diabetes mellitus. In Genetics of diabetes mellitus, Kobberling J, Tattersall RB, eds. Now York: Academic Press, 1982: 261-70.

5. Johansen K. Milid diabetes in young diabetics: clinical aspects and plasma insulin response pattern. Acta Med Scand 1973; 193: 23-33.

6. Barbosa AJ, King R, Goetz FC. Plasma glucose, insulin, glucose and growth hormone in kindreds with maturity onset type of hyperglycemia in young people. Ann Intern Med 1978; 88:595-601.

7. Faber OK, Thomsun M, Binder C, Platz P, Svejgaard A. HLA antigens in a family with maturity onset type diabetes mellitus. Acta Endocrinol 1978; 88: 329-38.

8. Panzram G, Savage PJ, Nagulesparan M, Howar BV, Pettitt DN, Lisse JR, Arnoff SL, Bennett PH. Obesity, insulin resistance and diabetes mellitus in the Pima Indians. In: The genetics of diabetes mellitus. Kobberling J, Tattersall RB, eds. London: Academic Press, 1982: 243-50.

9. Serjeantson S, Zimmet P. Diabetes in the Pacific: evidence for a major gene. In Diabetes Mellitus: recent knowledge on aetiology, complications and treatment. Baba S, Gould MK, Zimmet P, eds. Sydney: Academic Press, 1984: 23-30.

10. Asmal AC, Dayal B, Jialal I, Leary WP, Omar MAK, Pillay NL, Thandaroyen FT. Non-insulin-dependent-diabetes with early onset in blacks and Indians. S Afr Med J 1981; 60: 93-96.

11. Mohan V, Ramchandran A, Snehalatha C, Mohan R, Bharani G, Viswanathan M. High prevalence of maturity onset diabetes of the young (MODY) among Indians, Diabetes Care 1985;8:371-74.

12. Fajans SS. Heterogeneity between various families with non-insulin dependent diabetes of the MODY type. In: The genetics of diabetes mellitus. Kobberling J, Tattersall RB, eds. New York: Academic Press, 1982: 251-60.

13. Mohan V, Ramchandran A, Snehalatha C, Viswanathan M. Maturity Onset Diabetes of the Young in Asian Indians. In: Proceedings of the German Society for Internal Medicine. Pfeiffer EF, ed. Munchen: J.F. Bergmann Verlag, 1987: 505-509.

14. Mohan V, Ramchandran A, Viswanathan M. Tropical diabetes. IN: Diabetes Annual 1. Alberti KGMM, Krall LP, eds. Amsterdam: Elsevier Science Publishers, 1985: pp 82-92.

15. Mohan V, Ramchandran A, Viswanathan M. Tropical Diabetes. In: Diabetes Annual 2. Alberti KGMM, Krall LP, eds. Amsterdam: Elsevier Science Publichers, 1986: pp 30-38.

16. Ramchandran A, Snehalatha C, Mohan V, Viswanathan M. Vascular complications in Asian Indian non-insulin dependent diabetic patients In: proceedings of the international symposium on Epidemiology of diabetes mellitus. Bangkok, Thailand . 1987; 70 (Suppl.2): 180-84.

17. Jailal I, Welsh NH, Joubert SM, Rajput MC. Vascular complications in Asian Indian non-insulin dependent diabetes of the young. S Afr Med J 1982; 62: 155-157.

18. Mohan V, Snehalatha C, Ramachandran A, Jayashree R, Viswanathan M. C-peptide responses to glucose load in maturity onset diabetes of the young (MODY). Diabetes Care 1985; 8: 69-72.

19. Jialal I, Joubert SM, Asmal AC, Jenkins N. The insulin and glucose responses to an oral glucose load in non-insulin dependent diabetes in the young. S Afr Med J 1982; 61: 351-54.

20. Jailal I, Joubert SM. Obesity does not modulate insulin secretion in non-insulin dependent diabetes in the young. Diabetes Care 1984; 7: 77.

21. Mohan V, Snehalatha C, Ramchandran A, Viswanathan M. Abnormalities of insulin secretion in 'healthy' off spring of Indian patients with maturity onset diabetes of the young. Diabetes Care 1986; 9: 53-56.

22. Thorrel JI, Nillson KO, Hager A. Absence of insulin resistance in four cases of mild juvenile diabetes. Acta peadiatr Scand 1975; 64: 245-52.

23. Jialal I, Naidoo C, Rajput M, Joubert SM. Evidence for insulin resistance in Indian patients with non-insulin dependent diabetes in the young. Horm Metab Res 1984; 16: 377-78.

24. Kolterman OG, Scarlett JA, Olefsky JM. Insulin resistance in non-insulin dependent (Type II) diabetes mellitus. In: New aspects of diabetes. Clinics in Endocrinology and Metabolism. Johnson DG, Alberti KGMM. eds. London, Philadelphia: Saunders, 1982.

25. Mohan V, Sharp PS, Aber VR, Mather HM, Kohner EM. Insulin resistance in maturity onset diabetes of the young (MODY). Diabeta Metab 1987; 13: 193-97.

26. Rotter JI, Rimoin DL. Genetics. In: Diabetes Mellitus, Vol 1. Brownlee M, ed. New York, Garland STPM Press 1981: 1-40.

27. Barbosa J. No linkage between HLA and maturity onset type hyperglycemia in the young. Diabetologia 1983; 24:137.

28. Mohan V, Hitman GA, Ramchandran A, Snehalatha C, Viswanathan M. MODY in South Indians: discrete entity or continuum of NIDDM? In: Proceedings of the Third Asian Symposium on Childhood and Juvenile Diabetes Mellitus, Bangkok, Thailand, 1989 (abstr p13).