The relationship between ABO/rhesus blood groups and type 2 diabetes mellitus in Maghnia, western Algeria

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Abstract

Background: To determine the relationship between ABO/rhesus (Rh) blood groups and type 2 diabetes mellitus in a western Algerian population.

Method: This case-control study was conducted at the Regional Hospital Centre of Maghnia, Tlemcen, from July 2008 to May 2009, involving 280 patients with type 2 diabetes mellitus and 271 healthy controls. Blood samples were collected from the patients after consent had been obtained. The samples were tested for ABO and Rh blood groups, using the Beth-Vincent and Simonin-Michon methods. The allele frequencies were calculated according to the Bernstein formulas.

Results: The χ^2 test results showed that there was no association between the ABO blood group and type 2 diabetes mellitus. It was also noted that the O blood group was distributed with the highest frequency among diabetic subjects (52.85%). For the Rh system, d allele frequency presence was higher in diabetics than in nondiabetics (0.3778 and 0.3644 respectively). The difference between phenotype frequencies was not significant ($p = 0.733$). The distribution of ABO/Rh blood groups between gender and ethnic group showed no significant difference ($p > 0.05$).

Conclusion: Our study confirms that there is no association between ABO/Rh blood group and diabetes mellitus in this Algerian population.

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Introduction

Since their discovery by Landesteiner in 1900, the ABO blood groups have been of great interest.[1] Many researchers have made attempts to determine the significance of particular ABO phenotypes for susceptibility to disease. The relationship between the ABO/rhesus (Rh) blood groups and various diseases has generated a great deal of interest.[2] Certain diseases show a strong association with the ABO/Rh blood groups, notably peptic ulcer and gastric cancer.[3] Several studies have investigated the possible relationship between type 2 diabetes mellitus and the ABO/Rh blood groups.[4] The blood groups of diabetics have been extensively studied since McConnell's suggestion in 1955 of an increased frequency of blood group A among these patients.[5] In Copenhagen, an excess of blood group O was found in male diabetics.[6] In Italy[7] and Trinidad,[8] results showed an increased frequency of blood group B among diabetics, but in Germany,[9] Glasgow,[10] Bangladesh[11] and a number of other recent studies,[12-16] no association was apparent between type 2 diabetes mellitus and blood group in the diabetics studied. Two recent studies, however, found a correlation between the A and O blood groups and diabetes mellitus.[2,17]

Several reports have evaluated the possible relationship between diabetes mellitus and the Rh blood groups. The San Antonio Heart Study (n = 1 237) found a high prevalence of type 2 diabetes mellitus among Mexican Americans, with a low prevalence among individuals with the CcDEe and CcDe phenotypes.[18] Similarly, a study of 150 patients with diabetes mellitus and 1 000 controls in Oslo, Norway, reported a deficiency of phenotypes with the CDe haplotype and an excess of those with the CDE haplotype among diabetics.[19] The opposite pattern was noted among diabetic patients and control subjects in Germany.[20]

The aim of this study was to ascertain whether ethnic grouping and cultural differences may be the cause of a particular relationship between ABO/Rh blood groups and type 2 diabetes mellitus in a western Algerian population.

Method

Selection of diabetic subjects

A total of 280 patients with type 2 diabetes mellitus were recruited by a simple random method to participate in a case-control study in the Regional Hospital Centre, Maghnia, Tlemcen. Patient recruitment lasted for 11 months, from July 2008 to May 2009.

The diagnosis of diabetes mellitus was made according to the American Diabetes Association criteria.[21] Persons were classified as diabetics if their venous blood glucose values were higher than or equal to 7 mmol/l, or if they were taking medication for diabetes at the time of the study.

Selection of control subjects

For comparison, 271 unrelated healthy individuals were randomly selected from routine medical or surgical check-ups. They were identified as healthy if their venous blood glucose values were less than 6.1 mmol/l and if they had never received any diabetic medication.

None of the controls (nondiabetics) or test subjects (diabetics) met the exclusion criteria.

Clinical investigation

The blood samples were collected by venepuncture, with 2 ml in EDTA bottles. The phenotypes ABO and Rh D were determined by the double method of Beth-Vincent and Simonin-Michon on a plate or in a tube with locally prepared monoclonal serum tests and red blood cells.

Statistical analysis

The χ^2 test was used to estimate the probability of difference distributions occurring by chance and probabilities of less than $p = 0.05$, as is conventional, indicating significant differences. In the two-by-two contingency tables, Fisher's exact test (two-tailed) replaced the χ^2 test if the assumptions underlying χ^2 were violated, namely in the case of small size or when the expected frequency was less than five in any of the cells.

The allele frequencies of A, B, O, D and d were calculated according to the Hardy-Weinberg and Bernstein methods (originating in 1903 and 1908 respectively).

Results

Table I shows the distribution of the ABO/Rh blood groups among diabetics and nondiabetics. Blood groups A, B and AB were more common in controls without diabetes than in diabetic patients. The values were 35.42%, 17.34% and 4.05% for nondiabetics with blood groups A, B and AB respectively, and 29.28%, 13.92% and 3.92% for diabetics. For blood group O, diabetics were more numerous (52.85%) than nondiabetics (43.17%). These differences,

Table I: ABO/Rh blood groups distribution among diabetics and non-diabetics

Group		Total	Phenotype frequency						Allele frequency				
			A	B	AB	O	Rh+	Rh-	A	B	O	D	d
Diabetics	n	280	82	39	11	148	240	40					
	%		29.28	13.92	3.92	52.85	85.71	14.28	0.1828	0.0937	0.7269	0.6221	0.3778
Nondiabetics	n	271	96	47	11	117	235	36					
	%		35.42	17.34	4.05	43.17	86.71	13.28	0.2221	0.1134	0.6570	0.6355	0.3644

Table II: Distribution of ABO/Rh blood groups between genders for diabetics and non-diabetics

Group		Total	Phenotype frequency						Allele frequency				
			A	B	AB	O	Rh+	Rh-	A	B	O	D	d
Diabetics													
Men	n	104	26	1	6	59	91	13					
	%		25	12.50	5.76	56.73	87.50	12.50	0.1679	0.0959	0.7531	0.6464	0.3535
Women	n	176	56	26	5	89	149	27					
	%		31.81	14.77	2.84	50.56	84.65	15.34	0.1917	0.0924	0.7110	0.6083	0.3916
Nondiabetics													
Men	n	107	38	23	3	42	97	9					
	%		35.51	21.49	2.80	39.25	90.65	8.41	0.2206	0.1353	0.6264	0.7100	0.2900
Women	n	165	58	24	8	75	139	26					
	%		35.15	14.54	4.84	45.45	84.24	15.75	0.2254	0.1022	0.6741	0.6031	0.3968

however, did not reach statistical significance (p = 0.149, χ^2 = 5.326). The allele frequencies for both diabetics and nondiabetics were, in order, O > A > B. The frequency of Rh-negative subjects in the diabetic group was higher than in the nondiabetic group (14.28% and 13.28% respectively), but none of these differences were statistically significant (p = 0.733) in these samples (χ^2 = 0.116).

The distribution of ABO/Rh blood groups between the genders for both diabetics and nondiabetics is shown in Table II. Blood groups O and AB were more dominant in the diabetic group among men (56.73% and 5.75% respectively) than women (50.56% and 2.84% respectively). Among the control subjects, the O and B blood groups were more common in women (46.06% and 18.18% respectively) than men (38.67% and 16.03% respectively). There was no significant difference in gender distribution among the test group (p = 0.365, χ^2 = 3.177) and the control group (p = 0.381, χ^2 = 3.069). For the Rh blood groups, the phenotype frequency of Rh-negative subjects in the diabetic group was higher in women (15.34%) than in men (12.5%). Inversely, in the control group, the male subjects represented a higher frequency (20.75%) than the female subjects (8.48%). No significant difference in gender distribution was noted between the diabetic (p = 0.512, χ^2 = 0.431) and the nondiabetic groups (p = 0.082, χ^2 = 3.030).

Table III gives the distribution of ABO/Rh blood groups between ethnic groups for diabetics. Blood group A had the largest phenotype frequency in the Nadrooma ethnic group (35.82), while the M'ssirda group displayed the lowest frequency for this blood group (20.40 %). Inversely, for the O blood group, the highest value was observed among the M'ssirda with 63.26% and the lowest frequency among the Nadrooma (46.26%). For blood groups B and AB, the highest frequency of B was marked in other ethnic

Table III: Distribution of ABO/Rh blood groups between ethnic groups for diabetics

Group		Total	Phenotype frequency						Allele frequency				
			A	B	AB	O	Rh+	Rh-	A	B	O	D	d
Beni Ouassine	n	66	20	5	4	37	55	11					
	%		30.30	7.57	6.06	56.06	83.33	16.66	0.2023	0.0706	0.7487	0.5918	0.4081
M'ssirda	n	49	10	8	0	31	46	3					
	%		20.40	6.32	0	63.26	3.87	6.12	0.1079	0.0853	0.7953	0.7526	0.2473
Nadrooma	n	67	24	9	3	31	58	9					
	%		35.82	13.43	4.47	46.26	86.56	13.43	0.2274	0.0940	0.6801	0.6335	0.3664
Maaziz	n	30	9	6	0	15	25	5					
	%		30	20	0	50	83.33	16.66	0.1633	0.1055	0.7071	0.5918	0.4081
Beni Boussaid	n	27	9	3	2	13	20	7					
	%		33.33	11.11	7.40	48.14	74.08	25.92	0.2302	0.0973	0.6938	0.4908	0.5091
Other	n	39	10	8	2	21	36	5					
	%		25.64	20.51	5.12	53.84	92.30	12.82	0.1377	0.1084	0.7337	0.6419	0.3580

Table IV: Distribution of ABO/Rh blood groups between ethnic groups for nondiabetics

Group		Total	Phenotype frequency						Allele frequency				
			A	B	AB	O	Rh+	Rh-	A	B	O	D	d
Beni Ouassine	n	70	31	7	4	28	59	11					
	%		44.28	10	5.71	40	84.29	15.71	0.2928	0.0819	0.6324	0.6036	0.3963
M'ssirda	n	65	14	15	2	34	59	6					
	%		21.53	23.07	3.07	52.30	90.77	9.23	0.1318	0.1407	0.7231	0.6784	0.3215
Nadrooma	n	38	13	7	1	17	32	6					
	%		34.21	18.42	2.63	44.73	84.21	15.79	0.2053	0.1115	0.6688	0.6026	0.3973
Maaziz	n	39	16	7	2	14	34	5					
	%		41.02	17.94	5.12	35.89	87.18	12.82	0.2663	0.1230	0.5990	0.6419	0.3580
Beni Boussaid	n	29	11	**7**	1	10	23	6					
	%		37.93	24.13	3.44	34.48	79.31	20.69	0.2344	0.1490	0.5871	0.5451	0.4548
Other	n	38	15	5	1	17	36	5					
	%		39.47	13.15	2.63	44.73	94.73	13.15	0.2392	0.0823	0.6688	0.6373	0.3326

groups (20.51%) and AB in the Beni Boussaid ethnic group (7.40%). The allele frequency exhibited an order of O > A > B in all the diabetics. No statistically significant difference was noted between various ethnic groups (p = 0.668, χ^2 = 12.146). Regarding the Rh blood group, a high frequency of the Rh-positive phenotype was observed among the M'ssirda (63.26%), and Rh-negative among the Beni Boussaid (25.92%). However, no significant difference was noted between these ethnic groups (p = 2.780, χ^2 = 6.285).

The distribution of ABO/Rh blood groups among ethnic groups for nondiabetics is given in Table IV. High A and AB phenotype frequencies were noted among the Beni Ouassine, with 44.28% and 10% respectively. The B and O blood groups were marked in the Beni Boussaid and M'ssirda ethnic groups (24.13% and 52.33% respectively). The allele frequency had the order of O > A > B in all of the ethnic groups. However, these differences were not statistically significant (p = 0.537, χ^2 = 13.855). The dominance of the positive Rh phenotype was noted in all ethnic groups, with the exception of the Beni Boussaid, who were predomonantly Rh-negative (20.69%). Nonetheless, no significant differences were found between the ethnic groups (p = 0.738, χ^2=2.755).

Discussion

The findings of the present study lend support to the hypothesis that genetic factors related to the distribution of some blood groups may not play a role in the development of type 2 diabetes mellitus. Blood group distribution in different population groups is an important consideration in health care.[22]

This study demonstrated that, in both the diabetic and the nondiabetic subjects, blood group O has the highest genotype frequency, followed in order by A, B, and AB. The results are very close to those of two previous studies carried out on the same Algerian population.[1,23]

Several reports have evaluated the possible relationship between diabetes mellitus and Rh blood group; however, the populations vary and the findings are inconsistent.[22] Our study demonstrated no association between the ABO blood group and diabetes mellitus in western Algeria. Our results are in agreement with those of many other studies, for instance the one Rahman[11] conducted in Bangladesh with a sample size of 2 312 patients and 8 936 controls, which reported that there was no association between the ABO blood groups and diabetes mellitus. Another study carried out in India, which included 511 patients with type 2 diabetes mellitus and 454 healthy control subjects, concluded that there was no association between ABO blood groups and type 2 diabetes mellitus.[15] In addition, reports from Germany,[9] Glasgow,[10] Oslo[19] and the USA, the latter on a population of predominantly African descent,[16] confirmed that the incidence of diabetes mellitus was not associated with the distribution of the ABO blood groups in these areas. However, an association of diabetes mellitus with the ABO blood groups was demonstrated in several studies.[5-8]

In the present study, there was no association between the A, B, AB and O phenotype frequency distribution and type 2 diabetes mellitus (p > 0.05). No significant results were found when the data were subdivided by sex or ethnic origin. Several studies have reported the same results.[15,24] The O blood group (see Table I) is more predominant in the diabetics than in the control subjects; this difference in frequency seems interesting.

The examination of blood group distribution among the population of this area, which consists of around ten thousand Arabs, thousands of non-Arabs and a few hundred Turks, sheds light on ethno-sociological transformations and genetic intermixing. From the 16th to the 19th centuries, many Turkish families migrated into Tlemcen. As a result, according to several studies, A gene frequency has increased and O gene frequency has decreased.[25]

On the other hand, a study carried out by Beadmore and Karimi in 1983 on two English populations living in two different areas showed that in both of them the distribution of blood groups differed according to social classes.[26] In classes I and II, the A phenotype was higher than in classes III and IV; the last showed an increase in phenotype O, and that could explain why Tlemcen, a city full of rich and highly qualified people, has a lot of the A phenotype and less of the O. These conclusions are in agreement with those of Zaoui,[1] and may explain the comparatively low prevalence of diabetes mellitus in this Algerian population, which is also characterised by a low phenotype frequency of the O blood group and a high socio-economic level.

The Rh blood system may play some role in the process of glucose metabolism and may influence the clinical expression of diabetes mellitus. However, our results suggest that there is no association between Rh blood groups and type 2 diabetes mellitus, in accordance with the results of previous studies.[19,20,27] The mechanisms through which control of particular genes on blood glucose levels is poorly understood; therefore, future investigations are necessary to elucidate fully the genetic contributions to type 2 diabetes mellitus.

The present study had several limitations, including a relatively small sample size and a small number of blood

markers. However, the major strengths of the study include its population-based design (as opposed to most other case-control studies) and the standardised protocol with quality control measures.

Conclusions

In this study, we wanted to prove the hypothesis that type 2 diabetes mellitus and blood groups (ABO/Rh) are interrelated, because of the broad genetic and immunological basis of both. However, it was concluded that blood groups did not differ significantly between the type 2 diabetes mellitus patients and the control subjects in this Algerian population.

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Declarations

Ethics approval

The study was approved by the Research and Ethics Committee of the Abou-Bekr Belkaïd University, Algeria.

Competing interests

The authors declared no competing interests.

References

1. Zaoui S, Fingold J, Meguenni K, Chabane Sari D. ABO and rhesus blood groups system in Tlemcen population, West Algerian. Biologie et Santé 2007;7(1):62-71.
2. Okon UA, Antal AB, Osim EE, Ita SO. The relative incidence of diabetes mellitus in ABO/rhesus blood groups in south-eastern Nigeria. Nigerian Journal of Physiological Sciences 2008;23(1–2):1–3.
3. Doll R, Swynnerton BF, Newell AC. Observation on blood group distribution in peptic ulcer and gastric cancer. Gut 1960;1:31–35.
4. Cooper RS, Rotimi CN, Kaufman JS, et al. Prevalence of NIDDM among populations of the African diaspora. Diabetes Care 1997;20(3):343–348.
5. McConnell RB. Discussion on the ABO blood groups and disease. Proc R Soc Med. 1955;48(4):291.
6. Anderson J, Lauritzen E. Blood groups and diabetes. Diabetes 1960;9:20–24.
7. Tedeschi G, Cavazzuti F. Contributo casistico allo studio dei rapporti tra diabete mellito e gruppi sanguigni. ABO & Rh Prog Med (Napoli). 1959;15(3):76–82.
8. Henry MU, Poon-King T. Blood groups and diabetes. West Indian Medical Journal 1961;10:156–160.
9. Maehr G. Distribution of ABO blood groups in diabetes mellitus. Wien Klin Wochenschr. 1959;71:536–538.
10. Craig J, Wang I. Blood groups and diabetes mellitus. Glasgow Med J. 1955;36:261–266.
11. Rahman M. Non-association of ABO blood groups with diabetes mellitus in Bangladesh. Bangladesh Med Res Counc Bull. 1976;2(2):144–146.
12. Sidhu LS, Malhotra P, Singh SP. ABO and Rh blood groups in diabetes mellitus. Anthropol Anz. 1988;46:269–275.
13. Iyengar S, Hamman RF, Marshall JA, et al. Genetic studies of type 2 (non-insulin-dependent) diabetes mellitus: lack of association with seven genetic markers. Diabetologia 1989;32:690–693.
14. Qureshia MA, Bhatti R. Frequency of ABO blood groups among the diabetes mellitus type 2 patients. J Coll Physicians Surg Pak. 2003;13:453–455.
15. Koley S. The distribution of the ABO blood types in patients with diabetes mellitus. Anthropologist 2008;10(2):129–132.
16. Nemesure B, Hennis A. Hypertension, type 2 diabetes, and blood groups in a population of African ancestry. Ethn Dis. 2006;16:822–828.
17. Kamil M, Ali Nagi Al-Jamal H, Mohd Yusoff N. Association of ABO blood groups with diabetes mellitus. Libyan J Med. 2010;5:4847.
18. Stern MP, Ferrell RE, Rosenthal M, et al. Associations between NIDDM, Rh blood group and haptoglobin phenotype: results from the San Antonio Heart Study. Diabetes 1986;35:387–391.
19. Berg K, Aarseth S, Lundevall J, Reinskou T. Blood groups and genetic serum types in diabetes mellitus. Diabetologia 1967;3(1):30–34.
20. Scholz W, Knuszman R, Daweke H. Distribution of blood and serum protein group characteristics in patients with diabetes. Diabetologia 1975;11(1):77–82.
21. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care. 2003 Jan;26 Suppl 1:S5-20.
22. Yamamoto F. Molecular genetics of ABO. Vox Sang. 2000;78 Suppl 2:91–103.
23. Ruffie J, Cabannes R, Larrouy G. Etude hémotypologique des populations berbères de M'sirda-fouaga (Nord-ouest oranais). Bull et Mém Soc d'Anthropologie de Paris. 1962;3(3–3):294–314.
24. Macafee AL. Blood groups and diabetes mellitus. J Clin Path 1964;17:39–41.
25. Binyildiz P, Buyukyuksel C. Urkiyea de gruplari dagilimi. Trip Fak Mecm (Turkey). 1979;42:166–175.
26. Beadmore JA, Karimi F. ABO genes are differentially distributed in socioeconomic groups in England. Nature 1983;303:522–524.
27. Buckwaltei JA, Knowler LA. Blood donor controls for blood group disease researches. Am J Hum Genet. 1958 Jun;10(2):164-174.