Likelihood of D heterozygosity in Mestizo Mexicans and Mexican Americans

N. D. Means, N. Bandarenko, K. J. Moise, Jr, and M. E. Brecher

Information on the gene frequencies of the Rh system in the Mexican or Mexican American population is currently not available in the medical literature, thus hindering management of pregnancies at risk for development of hemolytic disease of the newborn. Data from four recent large studies in the broader scientific literature of Mestizo Mexicans and Mexican Americans is reviewed. Gene frequencies are calculated from the pooled data. A table of gene frequencies in the Caucasian and African American population is provided for comparison. ***Immunohematology* 2001; 17:22–23.**

Key Words: hemolytic disease of the newborn, Rh system, Mexican D gene frequency

Estimation of the likelihood of heterozygosity for the D allele is useful in counseling couples at risk for hemolytic disease of the newborn due to anti-D. A high likelihood of paternal heterozygosity would prompt amniocentesis to determine fetal Rh typing using nucleotide amplification (polymerase chain reaction). A high likelihood for paternal homozygosity would require close clinical monitoring for fetal distress and possible therapeutic intervention. Many areas of the United States are currently experiencing a significant increase in the size of their Hispanic population, whereas other areas have had stable Hispanic populations for many years. Although tables estimating D zygosity are available for Caucasians, Asians, and African Americans, similar tables are not available for Mestizo Mexicans or Mexican Americans.

The term "Mestizo" is commonly used in Hispanic countries to describe persons of mixed European and American Indian ancestry. However, the Mestizo Mexican and Mexican American populations are actually a trihybrid mixture of Caucasian (41 to 71%), African (3 to 14%), and American Indian (27 to 55%) lineage.[1-4] A review of four recent large studies of Rh genotypes in the Mestizo population (one from Texas,[1] one from Arizona,[2] and two from Mexico City[3,4]) demonstrated comparable genotype frequencies (Table 1). A weighted gene frequency for the combined population (N = 2662) was used to create a zygosity table for all possible Rh positive phenotypes (Table 2). A comparison of the likelihood of zygosity for Rh positive phenotypes in Mestizo Mexicans and Mexican Americans, Caucasians, and African Americans[5] is given in Table 3.

Although this information will be useful when evaluating individuals of Mexican ancestry, caution must

Table 1. Rh allelic frequencies in Mestizo Mexican and Mexican Americans. Genotype nomenclature is given in Fisher-Race terminology (CDE) and their corresponding modified Wiener terminology (R/r). The Wiener terminology is commonly used by blood bankers.

Genotype Fisher-Race	Genotype Mod Wiener	Texas 948*	Arizona 730*	Mexico City 474*	Mexico City 510*	Weighted total 2662
DCE	R^Z	0.017	0.02	0.0206	0.101	0.035
DCe	R^1	0.438	0.443	0.4565	0.451	0.445
DcE	R^2	0.174	0.225	0.2126	0.2	0.200
Dce	R^0	0.065	0.042	0.0343	0.031	0.047
dCE	r^Y	0	——†	——†	0.0002	0.000
dCe	r'	0	0.013	0.0069	0.029	0.010
dcE	r''	0.003	——†	0.0032	0.001	0.002
dce	r	0.303	0.257	0.2659	0.185	0.261
Overall Rh negative		9.4%	7.3%	7.6%	4.6%	7.5%
Overall Rh positive		90.6%	92.7%	92.4%	95.4%	92.5%

*Numbers tested
†Not given

Table 2. Frequencies of Rh positive phenotypes and possible genotypes. The likelihood of heterozygosity for D is given for each phenotype.

Phenotype	Genotype Fisher-Race	Genotype Mod Wiener	Genotype frequency (%)	Liklihood of hetero-zygosity for D
CcDe	*CDe/cde*	R^1r	23.252	85
	CDe/cDe	R^1R^0	4.159	
	cDe/Cde	R^0r'	0.097	
CDe	*CDe/CDe*	R^1R^1	19.816	4.5
	CDe/Cde	R^1r'	0.921	
cDEe	*cDE/cde*	R^2r	10.439	85
	cDE/cDe	R^2R^0	1.867	
	cDe/cdE	R^0r''	0.017	
cDE	*cDE/cDE*	R^2R^2	3.994	1.8
	cDE/cde	R^2r	0.073	
CcDEe	*CDe/cDE*	R^1R^2	17.792	12
	CDE/cde	R^zr	1.805	
	cDE/Cde	R^2r'	0.414	
	CDE/cDe	R^zR^0	0.323	
	CDe/cdE	R^1r''	0.163	
	cDe/CdE	R^0r^y	0.000	
cDe	*cDe/cde*	R^0r	2.440	92
	cDe/cDe	R^0R^0	0.218	
CDE	*CDE/CDE*	R^zR^z	0.119	0.2
	CDE/CdE	R^zr^y	0.000	
CcDE	*CDE/cDE*	R^zR^2	1.381	1.0
	CDE/cdE	R^zr''	0.013	
	cDE/CdE	R^2r^y	0.002	
CDEe	*CDE/CDe*	R^zR^1	3.077	1.2
	CDE/Cde	R^zr'	0.036	
	CDe/CdE	R^1r^y	0.002	

Table 3. Comparative likelihood of heterozygosity for D (%) of Rh positive phenotypes in Mestizo Mexican and Mexican Americans, Caucasians, and African Americans*

Phenotype: antigens present	Mestizo Mexicans and Mexican Americans	Caucasians[5]	African Americans[5]
CcDe	85	90	41
CDe	4.5	9	19
cDEe	85	90	37
cDE	1.8	13	1
CcDEe	12	11	10
cDe	92	94	54

* Rare phenotypes such as CDE, CcDE, CDEe all have a likelihood of heterozygozity less than 2%. In other racial groups, the likelihood of being heterozygous for D is reduced because absence of D is so uncommon. [5]

be exercised when extrapolating this information to individuals from other Latin American countries, due to the possibility of differing ancestral admixtures. It is also important to note that, although probability of heterozygosity given in Tables 2 and 3 assumes that an individual with a certain phenotype is selected randomly from a population, if information is available regarding the phenotype of previous offspring of the parents, the calculation of the probability can be further refined.[6] In the future, it is anticipated that the use of gene amplification for determining RHD zygosity will improve our ability to counsel such patients.[7]

References

1. Cerda-Flores RM, Kshatriya GK, Bertin TK, Hewett-Emmett D, Hanis CL, Chakraborty R. Gene diversity and estimation of genetic admixture among Mexican-Americans of Starr County, Texas. Ann Hum Biol 1992;19:347–60.
2. Long JC, Williams RC, McAuley JE, et al. Genetic variation in Arizona Mexican Americans: estimation and interpretation of admixture proportions. Am J Phys Anthro 1991;82:141–57.
3. Tiburcio V, Romero A, De Garay AL. Gene frequencies and racial intermixture in a Mestizo population from Mexico City. Ann Hum Biol 1978;5:131–8.
4. Lisker R, Perez-Briceno R, Granados J, Babinsky de Rubens J, Armendares S, Buentello L. Gene frequencies and admixture estimates in a Mexico City Population. Am J Phys Anthro 1986;71:203–7.
5. Vengelen-Tyler V, ed. Technical manual. 12th ed. Bethesda, MD: American Association of Blood Banks, 1996: chapter 13.
6. Kanter M.H. Derivation of new mathematic formulas for determining whether a D-positive father is heterozygous or homozygous for the D antigen. Am J Obste Gynecol 1992;166:61–3.
7. Wagner FF, Flegel WA, *RHD* gene deletion occurred in the Rhesus box. Blood 2000;95:3662–8.

Norman D. Means, MD, and Nicholas Bandarenko, MD, Transfusion Medical Service, Dept. of Hospital Laboratories, University of North Carolina Hospitals, Chapel Hill, NC; Kenneth J. Moise, Jr., MD, Division of Maternal-Fetal Medicine, Dept. of Obstetrics and Gynecology, University of North Carolina Hospitals, Chapel Hill, NC; Mark E. Brecher, MD (corresponding author), Transfusion Medicine Service, CB#7600, University of North Carolina Hospitals, 101 Manning Drive, Chapel Hill, NC 27514.