CONCISE REPORT

Detection of Hemophilia A Carriers
Using Intragenic Factor VIII:C DNA Polymorphisms


A DNA polymorphism for an XbaI site in intron 22 of the human factor VIII:C gene extends the utility of DNA methods for carrier detection in families segregating for hemophilia A. While the DNA polymorphism detected by a BclI site in intron 18 of the factor VIII:C gene was informative for 41% of females studied, the BglI/intron 25 polymorphism provided no additional information because of apparent linkage disequilibrium. In contrast, the XbaI intron 22 polymorphism was useful in 53% of women who were informative (homozygous) for either the BclI or BglI polymorphisms. Using the BclI/intron 18 and XbaI/intron 22 intragenic polymorphisms, we could provide highly accurate information for 68% of women we studied who were at risk for carriership. The carrier status of the remaining 32% could be determined utilizing the closely linked TaqI/St14 DNA polymorphism.

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RESULTS AND DISCUSSION

Frequency of informative RFLPs. A woman was considered to be informative if she was heterozygous for an RFLP and the linkage phase of the DNA polymorphism and the normal or abnormal factor VIII:C allele could be established. The extragenic TaqI/St14 RFLP, which is closely linked, was informative in 103/106 (97%) of women studied.

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In contrast, the Bcl1/intron 18 RFLP was informative for only 38/93 (41%) of women. This latter result is in close agreement with the prediction of Gitschier et al of 42% heterozygosity from estimated allelic frequencies of 71% and 29% (2pq = 2 x 0.71 x 0.29 = 0.41).

The Bgl1/intron 25 RFLP was informative for 14/44 women studied (32%). This agrees with prior estimates of heterozygosity that ranged from 11% to 38%.

The Xbal polymorphic site in intron 22 was informative for 25/43 women (58%). The proportion of observed heterozygosity was slightly higher than the 48% expected from calculations based on previous reported allelic frequencies of 59% and 41% (2pq = 2 x 0.59 x 0.41 = 0.48).

Linkage disequilibrium between the intron 18 and intron 25 RFLPs. In a prior report, we noted that the intron 25 RFLP offered little additional information to that provided by the intron 18 RFLP. Among 44 females for whom we have analyzed both RFLPs, 14 were informative with both, three were informative with only the intron 18 RFLP, and 27 were not informative with either. A 2 x 2 contingency table testing for association of the two RFLPs suggests the intron 18 and intron 25 RFLPs are in strong linkage disequilibrium (X^2 = 32.6, p < 0.0001). Thus in our experience the intron 25 RFLP seems to have limited utility when compared to the intron 18 RFLP.

Added utility of the intron 22 RFLP. In contrast to the Bgl1/intron 25 RFLP, the Xbal/intron 22 RFLP was often informative in those women who were homozygous for the Bcl1/intron 18 RFLP (Fig 1). Among 38 women uninformative for the Bcl1/intron 18 RFLP, 20 (53%) were informative with Xbal/intron 22. Similarly, among 35 women uninformative with Bgl1/intron 25, 19 (54%) were informative with the Xbal/intron 22. These data suggest that the Xbal/intron 22 RFLP may be informative in about 1/2 of those females who are homozygous for the other two intragenic RFLPs. Assuming complete linkage equilibrium, analysis of the Bcl1/intron 18 and Xbal/intron 22 RFLPs should be informative for about 72% of the females (41% + 0.53 x 59% = 72%); however, results obtained in earlier studies demonstrated that these polymorphisms are not in complete equilibrium. In our study, this combination was informative for 25/39 (64%) women for whom we had complete data, suggesting that analysis of these two RFLPs could enable highly accurate carrier detection for about 2/3 of female relatives of males with hemophilia A. Moreover, our results suggest the optimal strategy for applying DNA techniques to both carrier detection and prenatal diagnosis of hemophilia A is to utilize analysis of the intron 18 and intron 22 RFLPs.

Uninformative with intragenic RFLPs. Of the 14 of 39 women who were uninformative with any of the three intragenic RFLPs studied, all were informative with the TaqI/St14 RFLP. Although there is a significant (3.85%) risk of recombination between this RFLP and the factor VIII:C gene (I. Peake, personal communication, January 1987), results obtained can be used to establish carriership with diagnostic accuracy that likely exceeds that obtained through conventional factor analysis.

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