Detection of Rare and Unknown Mutations in β-talassemia Traits in Iran

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Abstract
Beta-thalassemia, by its high frequency and heterogeneity, constitutes a real problem of health in Iran. About 13 beta globin mutations encompass 70-90% of mutations spectrum in Iran, the rest are rare or unknown. In this study six mutations of the codon IVS1-130(G-C), Fr16 (-C), codon35 (-C), fr23/24(-G), codon8 (+G) and codon 20 (GTG-GAG) were recognized and added to spectrum of beta globin mutations in Iran, Using ARMS/PCR and DNA sequencing. Three latter cases are reported for first time.

Keywords: Beta-thalassemia, Unknown mutations, Iran

Introduction
β-thalassemia is a heterogenous group of autosomal recessive disorders that results in β-chain hemoglobin. Due to climatic, geographic and ecological conditions, β-thalassemia is one of the most frequent hemoglobinopathies and single gene disorders in Iran (1, 2, 3, 4, 5, 6, 7, 8). It is the first priority for the Iranian Ministry of Health concern with genetic disorders. Prevention of β-thalassemia implies knowledge of molecular spectrum occurring in the population at risk. This knowledge is necessary when a prevention protocol is applied to multiethnic population (6, 7, 8). So the detection of all mutations of β-thalassemia in each population is the major goal in prevention, and is especially helpful for prenatal diagnosis. Up to now more than 200 different mutations in the β-globin gene have been reported (3). About 13 mutations encompass 70 to 90 percent of mutations spectrum in Iran (1, 2, 6). These mutations are called common β-globin mutation in Iran; the others (10-30%) are rare or unknown.

Materials and Methods
25 patients and carriers of β-thalassemia who had been referred to clinics for detection of their mutation, but their mutation had not been detected, were selected. DNA was extracted from the collected peripheral blood by proteinase K and Isopropanol method (9). The concentration of extracted DNA was determined by spectrophotometry. ARMS/PCR (10) was done by primers codon 15 N, codon 15 M, I vs1 –130m/common D, control A, control B. PCR reaction mixture was tris (pH=8/3) 10mM, KCL 50mM dntp mixture 200mM, 10x buffer containing 50Mm Mg, Taq DNA polymerase 0/5 unit DNA 50ng /ml, 10pmol primers. Time and temperature were, initiation denaturing 94 ْC for two minutes and one cycle, denaturing 94C, annealing 57 C and extension 72C for one minute and 30 cycles. The ARMS/PCR products were electrophoresed on 2% Agars gel. They were stained with etidum bromid. To screen PCR products on acryl amid gel, PCR reaction mixture (11) was the same for ARMS/PCR except primers. Primers were common C and IVS1 –1 normal (Table1). PCR products were electrophoresed on 8 acryl – amid gel. They were stained with AGNO3. The PCR products in which there were shift on acrylamid gel, amplified by ARMS / PCR for mutation of framshift 16 using of primers of Common C, Fr 16N or Common C, Framshift 16M. Using primers of Common D and Codon 8 normal, Commonc, Ivs1-1 normal two regions on beta globin gene were amplified by PCR. PCR products were sequenced by automated DNA sequencer based on Sanger method (12).

Results
ARMS/PCR was used to screen mutations of I vs1-130 (G→C) and codon 15 (TGG → TGA). Four cases of I vs1-130 were detected. They were carries for B-thalassemia. No cases were detected for mutation of codon 15. Figure1 shows the results of ARMS/PCR. Using two primers of I vs1-1 N and common C, a 272bp fragment from nucleotid of –18 in region promoter to end of exon one was amplified. Using two primers of codon 8 N and common D, a 490 bp fragment from nucleotid of 24 of exon 1 to nucleotid of 79 of second intron was amplified. It is noted that the major of beta globin mutations are located in these part of gene. Using of two primers of I vs1-1 and common C with usual PCR, a shift was seen and after it ARMS/PCR proved which mutation of Fr16 is. Two cases of Fr16 were detected (Figures 1and 2). Using DNA sequencing, four mutations of codon 8(+G), codon 35(-C), Fr23/24(-G), codon20 (GTC→GAC) were detected (Fig 3).

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**Table 1:** The sequences of primers

<table>
<thead>
<tr>
<th>Primers</th>
<th>Sequences</th>
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<tbody>
<tr>
<td>Common C</td>
<td>5' ACATCACCCCTGTGGAGCCAC3</td>
</tr>
<tr>
<td>Common D</td>
<td>5'GAGTCAAGGTCGAGAGATGCAAGGA3</td>
</tr>
<tr>
<td>IVSI-1 Normal</td>
<td>5'TTAAACCTGTCTTTGTAACCTTGATACGAAC3</td>
</tr>
<tr>
<td>Codon8 Normal</td>
<td>5'ACACATCGTGGACCTGAAGCCTGAGCAGA3</td>
</tr>
<tr>
<td>IVSI-130 Normal</td>
<td>5'TCTGCCATTGGTGATTCCCCACCCCTAG3</td>
</tr>
<tr>
<td>IVS1-130 Mutant</td>
<td>5'CCTGGCATTTGGTGATTCCCCACCCCTAC3</td>
</tr>
<tr>
<td>Fr 16 Normal</td>
<td>5'TCAACCACACTCTCATTCCACGTTCCACGTTCC</td>
</tr>
<tr>
<td>Fr 16 Mutant</td>
<td>5'TCAACCACACTCTCATTCCACGTTCCACGTTGCC</td>
</tr>
<tr>
<td>Control A</td>
<td>5'CAATGTATCATGCTTCTTTTGACC3</td>
</tr>
<tr>
<td>Control B</td>
<td>5'GAGTCAAGGCTGAGAGATGCAAGGAG3</td>
</tr>
</tbody>
</table>

**Fig. 1:** Electrophoresis of PCR products on 8% acrylamide gel which were amplified by common C and IVS1-1 normal. Line 1 and 2 are positive for fr 16 but line 4 is normal. Line 5 for VIII DNA size marker. There are shift in lines 1 and 2.
Fig. 2: Electrophoresis of PCR products on 2% agarose gel which are amplified by allele specific primers of normal and mutations of ivs1-130 and Fr 16. Lines 1 to 4 are for ivs1-130. Line 1 and 2 are for one person and line 3 and 4 for others. Line 1 and 3 are for normal alleles and line 2 and 4 are for mutant alleles. Both of line 1, 2 and 3 have 301bp but line 4 has not. So the person on the left (line 1, 2) is positive for Ivsl-130 and is heterozygote. The person on the right (lines 3, 4) is normal for this mutation. Lines 6-9 are for Fr 16. Left person (lines 6, 7) is positive for Fr 16 but right person (lines 8, 9) is not. Bands of 861bp are products of control primers of A and B, which are seen above all lines.

Fig. 3 (from top to bottom): Sequence obtained from automated DNA sequencing which are sequenced by common C and common D primers:
A- There is an insertion of G in codon 8. B- There is a transition of T→A in codon 20 which is caused valin codon converted to golotamic acid. There are two peaks in this site. One of them belongs to a and the other to T. So this person is heterozygote for this mutation. C- Occurrence of mutation caused change and overlap of nucleotid in this case. according to peaks there are two conditions CACCAACTT and CACAACCTT, normal and mutation alleles respectively, i.e C is deleted. Because primer of common D (reverse primer) has been used, in fact G is deleted. Position of this mutation is between codon 23/24 (frame shift 23/24). D- Occupation of frame shift mutation caused change and overlap of nucleotid in upstream of codon 35. In this case according to peaks, There are two conditions, CAAGGTA and CAAGGGTA (mutant and normal allele respectively), i.e G is deleted because primer of common D (reverse primer) has been used for DNA sequencing, in fact C is deleted. The person is heterozygote for this mutation.
Discussion

β-thalassemia disease has high heterogeneity in molecular level. Up to now, more than 200 different mutations in β-globin gene have been reported (3), and in each population and race only a little of them cause disease (1, 2, 3, 5, 6, 9). Based on the study which had been initiated since 1991 (1, 2, 3, 4, 6, 7, 8) the majority of common mutations have been recognized in Iran. The origins of these mutations are Mediterranean, Mid-East and Assian –Indian (3, 4, 13, 14). In all of these studies, a number of mutations always have been unknown. The rate of unknown mutations was about 3 to 10 percent depend on the country. In this study 25 patients and carriers of unknown β-thalassemia mutations from different parts of Iran were selected randomly. The spectrum mutations of β-thalassemia are similar to neighboring countries (3, 13, 14). For this reason, we selected Ivs1-130 (G→C), codon 15, and Fr16 (-C) for screening. Ivs1-130 had been reported in Turkey (14), this mutation causes change in the splice junction site, so affects in splicing process. Fr16 (-C) had been reported in 1984 in Assian-Indian population, and also in Iran (15). This is a kind of frameshift mutation. Fr16 (-C) mutation was detected by electrophoresis of PCR production on 8 percent acrylamid gel compared to normal sample. This method is similar to SSCP but here double strand of DNA is electrophoresed. Using DNA sequencing, four kinds of mutations were detected. These were codon 35(-C), codon 8(+G), Fr23/24(-C) and codon 20 (GTG→GAG). All of these mutations are kind of frameshift except codon 20 (GTG→GAG). Codon 35(-C) was detected in 1989 in Malay population (16). Mutations of Fr23/24(-G), (+G), codon 8(+G) and codon 20 (GTG→GAG) are new mutations and have not reported up to now. It is noted that codon 8(+G) is different from the mutation of frameshift 8/9(+G) which is common in Iran. In the whole, the mutations of 10 cases (40%) from 25 cases were detected. The others were not detected by these methods.

Acknowledgment

It is appreciated the sincer cooperation of Amini F, Banihashemi S, Andonian L, Mohammadi A.

References