

## Molecular analysis of vitamin D receptor gene polymorphisms rs2228570 (FokI) and rs1544410 (BsmI) in patients with Behcet's Disease

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**Abstract:** Recent studies have shown vitamin D3 has immune-modulatory effect. The functional differences in the immune-modulatory action of vitamin D is mediated via the vitamin D receptor (VDR) gene polymorphisms. In this study, we assessed the association between the two common polymorphisms of VDR gene (FokI, BsmI) and Behcet's Disease (BD), A chronic inflammatory and multisystem disorder. Using polymerase chain reaction and restriction fragment length polymorphism, we analyzed the prevalence of the common polymorphisms of VDR gene in patients with BD (n=50) and controls (n=50) in an Iranian Azari population. A significant difference was found for the FokI polymorphism between the BD and the control group. The f allele frequency of 26% was present in BD patients compared to 13% of controls and was significantly associated with BD (P = 0.03); (OR=0.42, 95% CI=0.2-0.88). There was no significant difference in the polymorphisms BsmI between the case and control groups. Accordingly, the FokI variant remains a candidate functional polymorphism; the f allele isoform interacts with the basal transcription factor HB less efficiently than does the F allele isoform, providing a possible mechanism for the reduced transactivation associated (connected) with this allele. The association between VDR polymorphisms and autoimmune diseases varies across different ethnic population. Results of our studies could be followed by further studies with more patients to discover other relationships.

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### 1. Introduction

Behcet's disease (BD) is chronic inflammatory and multisystem disorder characterized by recurrent mouth and genital ulcers, uveitis and skin lesions. The BD is prevalent in East Asian countries including Iran (1,2). The prevalence in Iranian population is 80 cases per 100,000 (3). The etiopathogenesis of the BD have not been clearly defined (4,5). However, both genetic and environment factors have been suggested as causative and developing factors for the disease (6).

In recent laboratory and Epidemiological studies, have convincingly shown that vitamin D play a significant role in the regulation and modulation of immune system (7-11). Vitamin D deficiency associated with autoimmune disease and has suggested that the active metabolite of vitamin D (1,25-Dihydroxyvitamin D3 (1,25(OH)2D3, calcitriol) decreases the development and incidence of autoimmune disease (12-14). Vitamin D has immunosuppressant properties and modulates lymphocyte activity. Conceivably, these effects of

vitamin D may be important in the pathogenesis of Behcet's Disease (15). The biological effect of vitamin D is thought to occur by binding to its receptor (VDR) which belongs to the steroid receptor superfamily. VDR gene polymorphisms cause functional differences in immuno-modulatory action of vitamin D. This receptor is widely expressed in many cell types including antigen-presenting and lymphocytes cells (16-18). Indeed, using the VDR, vitamin D transmits signals to target cells, that is composed of both conserved DNA binding and ligand binding domains. The DNA binding domains act as the regulator of gene transcription (19). Immune cells produce a hydroxylase enzyme which cause convert 25-OH-D to 1,25-OH<sub>2</sub>-D, that is the functional form and an important regulator of the expression of genes involved in the proliferation, differentiation, angiogenesis, and apoptosis of cells (20).

The VDR gene is located in the human 12q12-q22 region and contains more than 470 single nucleotide polymorphisms (SNPs), some of which modulate 1,25-Dihydroxyvitamin D<sub>3</sub> uptake (21,22). Therefore, alteration in these polymorphisms which lead to point mutation can be considered as candidate variants to the disease. The most common polymorphisms (SNPs) of the VDR include rs2228570 (FokI) in exon 2 and rs1544410 (BsmI) that located in the intron separating exons 8 and 9 (22-26). Even more recent attention has focused on the possible role of these variants in the development of auto inflammatory and other disease related to immune system. The aim of this study is to investigate the most common polymorphisms of the VDR gene in Iranian Azari patients with BD.

## 2. Material and Methods

This cross-sectional study was conducted in the Connective Tissue Disorder Research Center and Tabriz Genetic Analysis Center of University of Medical Sciences, from February 2012 to May 2013. All participants have given an informed written consent, and the study protocol was reviewed and approved by the ethics committee of Tabriz University of Medical Sciences, which was in compliance with the Helsinki declaration. We recruited 50 Iranian native Azari patients with BD. The diagnosis of BD was based on the criteria of the International study Group (35). BD patients included 29 men and 21 women who were between 11 and 65 years of age ( $34.02 \pm 7.39$  years). Controls included 26 men and 24 women who were between 21 and 74 years of age ( $34.42 \pm 8.27$  years). A control group of 50 unrelated, healthy Iranian individuals who had no known medical problems from a health screening questionnaire were enrolled. We applied salting out

procedures to extract genomic DNA from blood samples which were collected in EDTA tubes (15,28). The FokI, BsmI, and polymorphic sites were considered in this study. Polymerase chain reaction (PCR) was performed by using their sets of primers (15) using the Techgene thermo cycler (Techne). After initial denaturation for 5 min at 95°C, samples were subjected to 30 cycles of amplification, 25s at 94°C, 20s at their primer pair annealing temperature and 20s at 72°C. The final step was a 5 min hold at 72°C. PCR products were digested with suitable amounts of reference restriction enzymes (Fermentas, Lithuania) in the restriction protocol according to the manufacturer's instructions. Digestion products were electrophoresed on 3% agarose gel containing 3 µl safe stains. The polymorphism was documented by photographing under UV illumination. All data regarding to restriction enzymes and their restriction patterns are in Table 1. Aliquots of 0.1 U of FokI, BsmI of restriction enzymes (Fermentas, Lithuania) and 2µL buffer were added to 5µL of the VDR PCR products. The alleles were designated as b (825 bp fragment) and B (650 bp and 175 bp fragments) for BsmI, f (265bp) and F (196 bp and 69 bp fragments) for FokI. We compared allele and genotype frequencies between the patient and control groups using the Chi2 test (MedCalc 11 software). P levels less than 0.05 were considered significant. The strength of associations was assessed by computing the odds ratios (ORs).

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### 3. Results

FokI genotype frequencies for the BD and control groups were FF:Ff:ff=52%:44%:4% and 74%:26%:0%, respectively; ( $P=0.04$ ). The ff genotype was significantly associated with BD. In addition, the f allele frequency of 26% was present in BD patients compared to 13% of controls and was significantly associated with BD ( $P = 0.03$ ); ( $OR=0.42$ , 95%  $CI=0.2-0.88$ ). So, the FokI VDR polymorphism was associated with susceptibility to BD.

There was no contribution of the VDR polymorphisms BsmI to BD. BsmI genotype frequencies for the BD and control groups were BB:Bb:bb=34%:28%:38% and 34%:30%:36%, respectively; ( $P=0.97$ ). Also, the frequency of the B and b alleles in patients and controls was similar at 47%:53% and 49%:51%, respectively, ( $P=0.8$ ) ( $OR=0.92$ ; 95% $CI=0.53-1.6$ ). Hardy-Weinberg principle was met in all groups (Table 2) and it was significant for BsmI ( $P<0.001$ ) and no bias occurred for FokI polymorphism, ( $P>0.05$  for all the analyses).

**Table 1** Characteristic features of the 2 studied polymorphisms in the vitamin D receptor (VDR) gene

Polymorphism fragments (bp)	Location in VDR gene	Restriction site	Digested alleles	Primer sequence	Annealing temperature (°C)	Digestion protocol	length (bp)
<i>BsmI</i> 650, 175	Intron-8	GAATGC (1/-1)↓	<i>B<sub>1</sub>b<sub>2</sub></i>	F: 5'-CAACCAAGACTACAAGTACCGGTGTCAGTGA-3' R: 5'-AAC CAG CGG GAA GAG GTC AAG GG-3'	63	37 °C overnight	825
<i>FokI</i> 196, 69	Exon-2	GGATG (9/13)↓	<i>F<sub>1</sub> f</i>	F: 5'-AGCTGGCCCTGGCACTGACTCTGCTCT-3' R: 5'-ATGGAAACACCTTGCTTCTTCTCCCTC-3'	68	37 °C overnight	265

**Table 2**

Comparison of allele and genotype frequencies for the *FokI* and *BsmI*, VDR polymorphisms between patients with Behcet's disease, and healthy controls.

SNP	Genotype frequency			$\chi^2$ (Pvalue)	Allele frequency		(%) $\chi^2$ (Pvalue)	OR (95%CI)
HWE $\chi^2$ (Pvalue)								
<u>FokI</u>	F/F	F/f	f/f		F	f		
								0.42 (0.2-0.88)
BD	26(52%)	22(44%)	2(4%)	0.04	74 (74%)	26(26%)	0.03	
0.09								
Controls	37(74)	13(26%)	0		87(87%)	13(13%)		
<u>BsmI</u>	B/B	B/b	bb		B	b		
								0.92
<0.001								BD
17 (34%)	14(28%)	19(38)	0.97	47(47%)	53(53%)	0.8	(0.53-1.60)	
Controls	17(34%)	15(30%)	18(36%)		49(49%)	51(51%)		

$P = 0.005$  for comparisons of genotype frequencies and allele of *FokI* (FF,Ff,ff) and *BsmI*(BB,Bb,bb) VDR polymorphisms, in the Behcet's disease group and control group. SNP, single-nucleotide polymorphism; BD, Behcet's disease; OR, Odds ratio; 95%CI, 95% confidence interval; HWE, Hardy-Weinberg equilibrium.

#### 4. Discussions

In the study, we investigated the possible association between the VDR gene polymorphisms in Iranian Azari patients with BD. We did not find that BsmI polymorphisms are associated with an individual's susceptibility to BD. Similarly, a meta-analysis found no evidence linking the BsmI VDR polymorphisms to BD in Tunisia (15). These findings were similar to results to studies in other autoimmune diseases, for example, Founded association of BsmI VDR polymorphism in patients with autoimmune thyroid diseases in china (32) MS in northwest Greece (33), and BsmI polymorphism with lupus and MS in Iran (34,35), lupus in Thailand (36) type 1 diabetes mellitus in Portugal (37) However, In Taiwanese (24) and Chinese (38) populations, the B allele of the BsmI VDR polymorphism was significantly associated with lupus. This apparent discrepancy may be related to the etiopathogenic differences between BD, lupus and ethnic populations. The BsmI VDR polymorphism does not appear to change VDR gene expression or VDR function. Diseases associated with these polymorphisms are therefore most probable caused by linkage disequilibrium with other functional variation within the VDR gene or with another closely linked gene or genes (21).

In contrast to the BsmI VDR polymorphism the FokI polymorphism was associated with susceptibility to BD in our Iranian Azari population, similar to the study of association between type 1 diabetes mellitus and the FokI VDR polymorphism in Italy (39) and with Autoimmune Addison's disease in Germany (40). This finding in contrast to the similar studies in BD and RA patients in Tunisian (15). In our study, a significant relationship was observed between f allele and Behçet's disease, but the study in Tunisian, this relationship was determined between F allele and BD and RA. However, no associations were found between Multiple sclerosis and the FokI VDR polymorphism in Netherlands (41) type 1 diabetes mellitus and the FokI VDR polymorphism in Iran (42), Portugal (43) and Germany (44).

The FokI site polymorphism in exon 2 of the hVDR gene has two variants differing from each other by three amino acids: the f/ M1 variant has 427 amino acids and the F/M4 variant 424 amino acids. The shorter (F/M4) receptor seems to be originated from the divergence of hominids from apes and has been called a "neomorph" (45), yet it actually includes about 65 Percent of VDR gene alleles in human subjects (46-53). This predominance of the F/M4 allele indicates an evolutionary advantage in human (54).

Accordingly, the FokI variant remains a candidate functional polymorphism; the f allele

isoform interacts with the basal transcription factor HB less efficiently than does the F allele isoform, providing a possible mechanism for the reduced transactivation associated (connected) with this allele (18). Also, Colin et al, confirm the higher activity of the 424 aa short VDR variant, (55) found that phytohemagglutinin stimulated growth of peripheral blood monocytes differs by FokI polymorphism. They found that the one-half maximal concentration for 1,25(OH)<sub>2</sub> vitamin D inhibition of phytohemagglutinin-stimulated growth was noticeably higher for cells containing the full-length VDR isoform (i.e., Ff and ff genotypes) than for those with the shorter isoform (FF genotype). Noticing the fact that recent studies have shown the immune-modulatory effect of vitamin D3 through the down-regulation of Toll-like receptor (TLR) expression in human monocytes. Inflammation triggered through TLR2 and TLR4 is important in the pathogenesis of BD (56). Nevertheless, serum 25-hydroxyvitamin D levels are decreased in patients with BD (4). This may be linked to vitamin D receptors functional polymorphisms. These factors together may increase susceptibility and promote the development of clinical manifestations of BD. Also, it seems that environmental factors that influence levels of active vitamin D are complex and a significant difference exists between vitamin D functions and VDR polymorphisms. It confirms that the association between VDR polymorphisms and autoimmune diseases varies across different ethnic population. Results of our studies could be followed by further studies with more patients to discover other relationships.

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