APOBEC3 Deletion is Associated with Breast Cancer Risk in a Sample of Southeast Iranian Population

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Breast Cancer (BC) is considered as one of the most important causes of death worldwide. Previous studies showed that apolipoprotein B mRNA-editing catalytic polypeptide-like 3 (APOBEC3) gene deletion significantly increased the risk of BC risk in Chinese and European women. The present study aimed to assess the possible impact of APOBEC3 deletion and the risk of BC in a sample of Iranian population. The APOBEC3 insertion/deletion (I/D) was analyzed in a case-control study including 262 BC patients and 217 healthy women. Polymerase chain reaction (PCR) was used to genotype the variant in APOBEC3 gene. The findings of this study showed that I/D as well as I/D+D/D genotype increased the risk of BC (OR= 1.57, 95% CI= 1.07-2.31, p= 0.025 and OR= 1.50, 95% CI= 1.03-2.19, p= 0.037, respectively) in comparison with I/I genotype. In conclusion, our findings suggest that APOBEC3 deletion polymorphism increased the risk of BC in an Iranian population in the southeast of Iran.

Key words: APOBEC3, breast Cancer, polymorphism, deletion

Every day many women are diagnosed with breast cancer (BC) all over the world. It can be considered the most common cancer amongst females globally and is also the leading cause of cancer-related death in many countries (1). BC is recognized as an important health care problem worldwide affecting approximately 1 million women annually (1-3). BC is also reported as one of the most frequent malignancies among Iranian women, comprising 21.4% of female cancers in this population (4). Interestingly, it was reported that BC affects Iranian women about a decade earlier than Western countries (5) which highlights the importance of research on BC in Iranian population.

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Several different factors are involved in BC pathogenesis while its exact etiology is complicated and not clearly identified. Our recent publications have provided evidence that genetic factors play important roles in the pathogenesis and progressions of BC in the population of southeast of Iran (6-10).

Somatic mutations in the genome are critical for transformation of normal cells into cancers. The existence of hundreds to thousands of mutations has been shown in most cancers (11-14).

APOBEC3s (A3s) gene cluster is located on chromosome 22q13.1-q13.2 including APOBEC3A, APOBEC3B, APOBEC3C, APOBEC3D, APOBEC3E, APOBEC3F, APOBEC3G, and APOBEC3H which are arranged in tandem and play key roles in intracellular defense against viral infection (15, 16). They all have the cytidine deaminase activity and are able to convert cytosine to uracil (15).

Through copy number variation (CNV) genome wide association study (GWAS), Long et al. realized a common (CNV) locus for breast cancer in Chinese women, which was located between the fifth exon of APOBEC3A and the eighth exon of APOBEC3B (17). The finding was also repeated among women of European ancestry (18). It has been shown that a 29.5 Kb deletion occurs between the fifth exon of APOBEC3A and the eighth exon of APOBEC3B, leading to the complete removal of the APOBEC3B coding region. Several studies have found an association between APOBEC3 deletion and risk of various cancers (17-19).

To the best of our knowledge there is no any report regarding the association between APOBEC3 deletion and BC in Iranian women, therefore in the present study we aimed to find out the impact of APOBEC3 deletion on BC risk in a sample of Iranian population.

**Material and methods**

**Patients**

This population- based case- control study was accomplished on 262 pathologically confirmed BC patients referred to Ali Ebneh Abitaleb hospital (Iran) from February 2009 until August 21014 and 217 age-matched population-based healthy women with no history of any type of cancer and not related to the patients. Ethical approvals for recruitment were obtained from the local Ethics Committee of Zahedan University of Medical Sciences, and informed consent was obtained from all patients and healthy individuals. Blood samples were collected in EDTA-containing tubes from patients and healthy controls and DNA was extracted using the salting out method. The quality of the isolated DNA was checked by electrophoresis on 1% agarose gel, quantitated spectrophotometrically and stored at -20 °C till further use.

**APOBEC3B insertion/deletion genotyping**

Genotyping of APOBEC3 insertion/deletion was performed using polymerase chain reaction (PCR) as described by Kidd et al. (20). One pair of deletion and two pairs of insertion (insertions 1 and 2) primers were used to distinguish between the insertion and deletion alleles. The primers sequences used were: Deletion-F: 5’-TAGGTGC-CACCCCGAT-3’, Deletion-R: 5’-TTGAGCAT-AATCTTACTCTTGAC-3’, Insertion1-F: 5’-TTGGTGCTGCCCCCTC-3’, Insertion1-R: 5’-TAGAGACTGAGGCCCAT-3’, Insertion2-F: 5’-TGTCCCTTTTCAGAGTTTGAGTA-3’, Insertion-2-R: 5’-TGGAGCCAATTAATCACTTCAT-3’. Deletion primers are specific to the deletion sequence configuration and generate a 700 bp PCR product upon amplification. Insertion 1 and Insertion 2 primers amplify only the insertion configuration and produce 490 and 705 bp products, respectively. Insertion and deletion PCR assays were performed separately, the products pooled, and visualized on a standard 2% agarose gel. In addition, each of the samples, which...
appeared to be homozygous for the deletion, was
genotyped using a second set of oligonucleotides
for the insertion (Insertion 2).

PCR was performed using 2X Prime Taq
Premix (Genet Bio, Korea). The amplification
procedure consisted of an initial denaturing step
for 5 min at 95 °C followed by 34 cycles: for 30 s at
95 °C, 24 s at 61 °C, and 17 s at 72 °C, as well as a
final extension step for 10 min at 72 °C. The
PCR products were visualized on a 3% agarose
gel containing 0.5 µg/ml of ethidium bromide
(Figure 1).

**Statistical analysis**

All statistical analyzes were computed using
statistical package SPSS 20 software. The
differences between the variables were evaluated by
chi-square test or independent sample t-test
according to the data. The association between
genotypes and BC were assessed by computing the
odds ratio (OR) and 95% confidence intervals (95%
CI) from logistic regression analyses. A p-value <
0.05 was considered as statistically significant.
According to our results, sample power was
computed for APOBEC3 deletion by comparison of
each genotype with the sum of other genotypes by
using STATA 10 software (Table 1).

Table 1. Association between the APOBEC3 gene deletion and breast cancer risk.

<table>
<thead>
<tr>
<th>APOBEC3 I/D variant</th>
<th>Cases n (%)</th>
<th>Controls n (%)</th>
<th>OR (95% CI)</th>
<th>P-value</th>
<th>Study power %</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/I</td>
<td>154 (58.8)</td>
<td>148 (68.2)</td>
<td>1.00</td>
<td>-</td>
<td>53</td>
</tr>
<tr>
<td>I/D</td>
<td>103 (39.3)</td>
<td>63 (29.0)</td>
<td>1.57 (1.07-2.31)</td>
<td>0.025</td>
<td>62</td>
</tr>
<tr>
<td>D/D</td>
<td>5 (1.9)</td>
<td>6 (2.8)</td>
<td>0.80 (0.24-2.66)</td>
<td>0.767</td>
<td>6</td>
</tr>
<tr>
<td>I/D+D/D</td>
<td>108 (41.2)</td>
<td>69 (31.8)</td>
<td>1.50 (1.03-2.19)</td>
<td>0.037</td>
<td>53</td>
</tr>
<tr>
<td>Allele</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>411 (78.4)</td>
<td>359 (82.7)</td>
<td>1.00</td>
<td>-</td>
<td>35</td>
</tr>
<tr>
<td>D</td>
<td>113 (21.6)</td>
<td>75 (17.3)</td>
<td>1.32 (0.95-1.82)</td>
<td>0.102</td>
<td>35</td>
</tr>
</tbody>
</table>
Results

The study groups included 262 pathologically confirmed BC patients with an average age of 48.9± 11.2 years and 217 healthy women with a mean age of 50.0± 13.0 years. The demographic information of patients group was summarized in Table 1. No significant difference was found between the groups regarding age (p= 0.306). The frequency distribution of the APOBEC3 I/D in BC cases and controls are shown in Table 1. Our results showed that I/D as well as I/D+D/D genotype increased the risk of BC (OR= 1.57, 95% CI= 1.07-2.31, p= 0.025 and OR= 1.50, 95% CI= 1.03-2.19, p= 0.037, respectively) in comparison with I/I genotype.

The D allele frequency in BC and controls were 0.216 and 0.173, respectively. The APOBEC3 D allele was not associated with the risk of BC in comparison with I allele (OR= 1.32, 95% CI= 0.95-1.82, p= 0.102).

The APOBEC3 I/D in controls (χ²= 0.052, p= 0.819) but not in cases (χ²= 6.88, p= 0.008) were in Hardy-Weinberg Equilibrium (HWE).

As shown in table 2, no significant association was observed among APOBEC3 deletion and clinicopathological parameters, including tumor stage, tumor grade, estrogen and progesterone receptors (ER, PgR), tumor size, and human growth factor receptor 2 (HER2).

Discussion

In the current study we examined the impact of APOBEC3 deletion on BC risk in a sample of Iranian population who were living in southeast of this country. The findings revealed that APOBEC3 deletion significantly increased the risk of breast cancer.

Table 2. Association between APOBEC3 A I/D polymorphism and clinicopathological characteristics.

<table>
<thead>
<tr>
<th>Variables</th>
<th>APOBEC3A</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I/I</td>
<td>I/D</td>
</tr>
<tr>
<td>Age (years) ≤50</td>
<td>84</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>64</td>
<td>42</td>
</tr>
<tr>
<td>Pathological type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductal</td>
<td>94</td>
<td>74</td>
</tr>
<tr>
<td>Others</td>
<td>47</td>
<td>25</td>
</tr>
<tr>
<td>Tumor size (cm) ≤2</td>
<td>35</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>77</td>
<td>79</td>
</tr>
<tr>
<td>TNM Stage</td>
<td></td>
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<tr>
<td>I</td>
<td>19</td>
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<td>II</td>
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<td>III</td>
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<tr>
<td>IV</td>
<td>13</td>
<td>24</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>II</td>
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<td>67</td>
</tr>
<tr>
<td>III</td>
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<tr>
<td>IV</td>
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<td>0</td>
</tr>
<tr>
<td>ER status</td>
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<tr>
<td>Positive</td>
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<td>78</td>
</tr>
<tr>
<td>Negative</td>
<td>37</td>
<td>43</td>
</tr>
<tr>
<td>PgR status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>62</td>
<td>79</td>
</tr>
<tr>
<td>Negative</td>
<td>41</td>
<td>42</td>
</tr>
<tr>
<td>HER2 status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>50</td>
<td>69</td>
</tr>
<tr>
<td>Negative</td>
<td>61</td>
<td>59</td>
</tr>
</tbody>
</table>
cancer among a sample of Iranian women. Long et al. performed a genome-wide association study in Chinese population and found a strong association between common deletion in the APOBEC3 gene and BC (17). Their findings showed the ORs of 1.31 (95% CI= 1.21-1.42) for a one-copy deletion and 1.76 (95% CI= 1.57-1.97) for a two-copy deletion. The result was also replicated among women of European ancestry and the findings showed that the deletion was significantly associated with breast cancer risk, with ORs and 95% CIs of 1.21 (1.02–1.43) for one-copy deletion and 2.29 (1.04–5.06) for two-copy deletion in comparison with no deletion (18).

Qi et al. investigated the possible association between APOBEC3 gene deletion and risk of epithelial ovarian cancer (EOC) in Chinese population (19). They found that one copy deletion as well as two-copy deletion of APOBEC3 significantly increased the risk of EOC in comparison with subjects with no deletions.

Addition evidences suggested that APOBEC3B is involved in mutagenesis of human cancers such as bladder, cervix, lung (adenocarcinoma and squamous cell carcinoma), head and neck as well as BC (21-24). APOBEC3B catalyzes genomic DNA deamination and it is a main mutational source in BC accounting for C-to-T transitions (25). Upregulation of APOBEC3B has been revealed in BC showing that it as an important source of enzymatic mutation and DNA damage that could inactivate the tumor suppressor TP53 gene (25).

We found no significant association between APOBEC3 deletion and clinicopathological parameters of BC patients. To the best of our knowledge, there is no data regarding the impact of APOBEC3 deletion on response to treatment as well as prognosis of BC patients.

In conclusion, our findings indicated that APOBEC3 deletion significantly increased the risk of BC in an Iranian population in southeast of Iran. Large sample sizes in diverse ethnicities are still required to certify our finding.

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Conflict of Interests
The authors declared no conflict of interests.

References


