Atopy phenotype in subjects with variants of the \( \beta \) subunit of the high affinity IgE receptor

Airong Li, Julian M Hopkin

Abstract

Background — Fc\(_c\)RI plays a central role in atopy, thus genetic variants of Fc\(_c\)RI-\( \beta \) may alter receptor function to enhance atopic responses and may manifest as a more severe atopic phenotype and more symptomatic atopic disease. The immunological and clinical features of atopy in children with and without the Leu 181 variant of Fc\(_c\)RI-\( \beta \) were compared.

Methods — Sixty British nuclear families, including 10 families with the Fc\(_c\)RI-\( \beta \) variant Leu 181, recruited via a young proband with atopic asthma were analysed for atopic parameters including total IgE, specific IgE, and clinical atopic disorder.

Results — Compared with other children (combined atopic and non-atopic subjects), maternally inherited Leu 181 was associated with increased levels of total IgE (odds ratio (OR) 4.82, 95% confidence interval (CI) 1.02 to 27.66, \( p < 0.01 \)) and a positive IgE response to grass pollen allergen (OR 7.45, 95% CI 1.56 to 35.52, \( p < 0.005 \)) but not wheeze (OR 1.97, 95% CI 0.56 to 7.69), asthma (OR 2.25, 95% CI 0.65 to 7.85), or required medications (OR 0.95, 95% CI 0.29 to 3.14). There were trends for each atopic parameter to be more marked in atopic children with maternally inherited Leu 181 than in atopic children without Leu 181. Children with maternal Leu 181 had significantly raised eosinophils but there was no difference in basophil levels compared with other atopic children.

Conclusions — The Leu 181 variant of Fc\(_c\)RI-\( \beta \), or another identified variant in linkage disequilibrium, may promote the development of atopy.

Keywords: atopy, genetics, Fc\(_c\)RI.
Table 1 Comparison of children with maternal Leu 181 and other atopic children

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Leu 181 (n = 13)</th>
<th>Others (n = 86)</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total IgE (kU/l)</td>
<td>11</td>
<td>62</td>
<td>2.37</td>
<td>0.49 to 11.36</td>
<td>NS</td>
</tr>
<tr>
<td>&gt;100</td>
<td>2</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>9</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPT-GP (≥2 mm)</td>
<td>10</td>
<td>49</td>
<td>3.78</td>
<td>1.28 to 18.36</td>
<td>0.049</td>
</tr>
<tr>
<td>Positive Wheeze</td>
<td>3</td>
<td>32</td>
<td>1.97</td>
<td>0.56 to 7.69</td>
<td>NS</td>
</tr>
<tr>
<td>Asthma</td>
<td>9</td>
<td>43</td>
<td>2.25</td>
<td>0.65 to 7.85</td>
<td>NS</td>
</tr>
<tr>
<td>Medications</td>
<td>8</td>
<td>54</td>
<td>0.95</td>
<td>0.29 to 3.14</td>
<td>NS</td>
</tr>
<tr>
<td>No</td>
<td>5</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SPT-GP = skin prick test to grass pollen; NS = not significant.

Receptor function in some way – for instance, by enhanced receptor binding for IgE or enhanced signal transduction – with a range of possible consequences in the many cells expressing FcεRI. Mast cells and basophils might release more mediators which promote local inflammation and thereby symptoms, or might enhance expression of cell contact signal including CD40 ligand in the presence of interleukin 4, causing more local B lymphocyte IgE production. In antigen presenting dendritic cells\(^9\) there might be a resultant enhancement of presentation of allergens; in the eosinophil\(^10\) there might be enhanced release of cytotoxic proteins.

The association of Leu 181 with such diverse atopic indices as raised total serum IgE, specific sensitisation to grass pollen, and increased eosinophil counts does not allow prediction of the likely cellular site or mechanism of action. Thus, broad ranging experiments on the possible functional consequences of the Leu 181 mutation and other mutations of FcεRI-β are required.

Discussion

The significant association between the presence of maternal Leu 181 and raised IgE levels in comparison with other children (combined atopic and non-atopic) supports the possibility that FcεRI-β may be the atopy locus on chromosome 11q13. A strong association has been shown between an intronic variant of FcεRI-β and each of atopic asthma, atopic rhinitis, and atopic eczema in a Japanese population.\(^5\) A coding variant of FcεRI-β, changing amino acid residue 237 from glutamic acid to glycine, shows a strong association with atopy and atopic asthma in Australian and Japanese populations.\(^6\) There are several possible genetic variant(s) within FcεRI-β or its controlling elements or perhaps a contiguous locus involved in atopy; this can only be resolved by more detailed genetic association studies at this location, proceeding to functional investigation.

Leu 181 lies within the fourth transmembrane domain of FcεRI-β, a critical region within the β subunit for efficient and intact FcεRI display, and might therefore influence receptor function in some way – for instance, by enhanced receptor binding for IgE or enhanced signal transduction – with a range of possible consequences in the many cells expressing FcεRI. Mast cells and basophils might release more mediators which promote local inflammation and thereby symptoms, or might enhance expression of cell contact signal including CD40 ligand in the presence of interleukin 4, causing more local B lymphocyte IgE production. In antigen presenting dendritic cells\(^9\) there might be a resultant enhancement of presentation of allergens; in the eosinophil\(^10\) there might be enhanced release of cytotoxic proteins.

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Thorax 1997 52: 654-655
doi: 10.1136/thx.52.7.654

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