Are BIC (miR-155) Polymorphisms Associated with Eczema Susceptibility?

Annika Sääf1, Ingrid Kockum2, Carl-Fredrik Wahlgren3, Ning Xu1, Enikő Sonkoly1, Mona Ståhle1, Magnus Nordenskjöld1, Maria Bradley1,3 and Andor Pivarcsi3

Departments of 1Molecular Medicine and Surgery and 2Clinical Neurosciences, Karolinska Institutet, and 3Dermatology and Venereology Unit, Department of Medicine Solna, Karolinska Institutet and Karolinska University Hospital, SE-17176 Stockholm, Sweden. *E-mail: andor.pivarcsi@ki.se

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Eczema (nomenclature according to the World Allergy Organization (1), also referred to as atopic dermatitis, OMIM#603165) is one of the most common chronic inflammatory skin disorders. Twin studies indicate a strong genetic contribution to the development of eczema, and genetic linkage analyses have identified several chromosomal regions and candidate genes linked to eczema susceptibility (2).

The discovery of microRNAs (miRNAs) has raised the question whether not only classical genes but also non-coding RNA genes may be involved in the pathogenesis of eczema. miRNAs are short (20–22 nt), non-coding RNAs, which suppress the activity of their target genes at the post-transcriptional level (3). miRNAs have important regulatory roles in virtually all biological functions, including development, cell proliferation, immune response and tumorigenesis. miRNA research has been a subject of interest in the dermatology field recently, and intriguing results have demonstrated the importance of miRNAs in skin biology (4–8). We have shown that skin from patients with eczema and psoriasis has an altered expression pattern of miRNAs compared with healthy skin (4, 9). However, the question still remains whether genes coding for miRNAs may be genetically associated with eczema susceptibility.

In searching for genes that are differentially expressed in eczema and healthy skin, we recently performed a large-scale gene-expression study (10). As shown in Fig. 1a, the BIC (B-cell Integration Cluster) transcript was found to be among the consistently over-expressed transcripts in eczema skin compared with healthy control skin. Furthermore, we demonstrated that BIC expression was induced by the application of Malassezia sympodialis (Fig. 1b; for experimental details see (10)). The BIC gene lacks any long open reading frame, which implies that it functions as an untranslated RNA. Interestingly, it encodes a non-coding RNA with an evolutionarily conserved secondary structure, which serves as the precursor of miRNA-155 (miR-155). This miRNA plays crucial roles in innate and adaptive immunity, inflammation and cancer (11). The increased level of BIC transcript in eczema skin is in agreement with our recent results obtained from the miRNA expression profiling of atopic eczema skin, showing that miR-155, the only known miRNA to be derived from the BIC transcript, is overexpressed in eczema skin (9).

Since the BIC transcript maps to an asthma and eczema susceptibility region on chromosome 21q21 (12, 13), it is intriguing to speculate that BIC/miR-155 may be genetically associated with eczema susceptibility. To test this hypothesis, we genotyped 5 single-nucleotide polymorphisms (SNPs), tagging the BIC/miR-155 chromosomal region (Fig. S1; available from: http://www.medicaljournals.se/acta/content/?doi=10.2340/00015555-1466), using genotypes from HapMap release #22 mapped to NCBI build 36 (dbSNP126), which was available in November 2007, in a Swedish eczema cohort consisting of 406 multiplex eczema families, including a total of 1,514 individuals. The eczema material was recruited at the Karolinska University Hospital in Stockholm, during 1995 to 1997 (14). A subset of these patients (n = 701; 46.3%) had eczema together with elevated allergen-specific IgE antibodies (age 6–20 years: > 263 kU/l; age > 20 years: > 122 kU/l) (14), i.e. atopic eczema (1).

As shown in Table I, there was a trend of association of the BIC gene with atopic eczema (rs987195, p < 0.04; rs1893650, p < 0.02; rs928883, p < 0.02), however, this
proved not to be significant upon correction for multiple testing (Bonferroni correction). One of these SNPs (rs1893650), which is located in the putative promoter region of the BIC/miRNA-155 gene, also showed a significant p-value in the whole eczema data-set (p = 0.05), including atopic and non-atopic eczema patients (data not shown). There was no association with rs1547355, which is not located in the promoter region or the gene itself, but in downstream genomic sequence. In summary, none of the nominally significant p-values were significant upon multiple testing.

Results from experiments performed with miR-155 knockout mice have demonstrated that it has essential roles in B- and T-cell responses and the organization of dendritic cell – T-cell interactions. Interestingly, miR-155-null mice had fewer class-switched antibodies after immunization compared with control mice and showed reduced IL-2 and IFN-γ production indicating that deletion of miR-155 compromised multiple aspects of adaptive immunity. We have identified miR-155 to be overexpressed in atopic eczema, mainly by activated CD4+ T cells, and shown that it is involved in the regulation of T-cell activation and proliferation via regulating 1 of its targets, cytotoxic T-lymphocyte antigen-4 (CTLA-4) (9). In summary, we show here that the BIC gene, the only known precursor of miR-155, is more highly expressed in lesional skin and in M. sympodialis patch-tested non-lesional skin of eczema patients compared with skin of healthy controls. Data presented here support our earlier results, but do not prove a genetic association between the BIC/miR-155 gene and atopic eczema. However, SNPs in the BIC/miR-155 gene may affect the expression/processing of miR-155 and contribute to susceptibility to eczema. Further research is needed to determine whether genetic variations in miRNA genes, or in their targets, may contribute to the susceptibility to chronic inflammatory diseases.

The authors declare no conflicts of interest.

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