

Netherton syndrome previously misdiagnosed as hyper IgE syndrome caused by a probable mutation in SPINK5 C

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Netherton syndrome (NS, MIM256500) is an autosomal recessive disorder that includes ichthyosis linearis circumflexa and a predisposition to allergies, asthma, and eczema, with hypereosinophilia, trichorrhexis invaginata, and elevated serum IgE levels. The genetic bases of Netherton syndrome are mutations in the gene *SPINK5*, and the Lymphoepithelial Kazal type related inhibitor, a serine protease inhibitor, is encoded by *SPINK*.

Here a case is presented which showed a probable splice site mutation in *SPINK5*, which was previously unknown in databases and the literature, to point out the misdiagnosis of Hyper IgE Syndrome in the early presentation of the phenotype. This case highlights that a genetic test can be critical for identifying NS. The finding of underlying mutations contributes to the understanding of Netherton syndrome and is instrumental in indicating a specific therapy. Notably, treatment with acitretin has significantly improved both the ichthyosis linearis circumflexa and eczema in our patient.

Key words: Netherton syndrome, eczema, hyper IgE syndrome, serum IgE, ichthyosis.

Netherton syndrome (NS, MIM256500) is an autosomal recessive disorder that includes ichthyosis linearis circumflexa (ILC) and a predisposition to allergies, asthma, and eczema, with hypereosinophilia, trichorrhexis invaginata, and elevated serum IgE levels.¹ Severe eczema and elevated serum IgE are common in various genodermatoses.^{2,3} In complicated cases, a genetic test can be critical for identifying NS. The genetic bases of NS are mutations in the gene *SPINK5*, and the Lymphoepithelial Kazal type related inhibitor, a serine protease inhibitor, is encoded by *SPINK*.¹

We think it is valuable to share this case, which showed a probable splice site mutation in *SPINK5*, which was previously unknown in databases and the literature, to point out the misdiagnosis of Hyper IgE Syndrome (HIS) in the early presentation of the phenotype.

Case Report

A four-year-old male presented to the dermatology clinic. He was the son of consanguineous parents (first cousins) who showed no signs of skin disease. His parents described the boy as having uneasiness,

irritability, intensive scratching, and red scaly patches all over his body and scalp. He was given intravenous IgG therapy because of his diagnosis of HIES for one year, with no benefit seen.

Collodion membrane and congenital erythroderma were recorded in his medical files at birth (Figs. 1a and 1b). Numerous consultations and laboratory analyses from birth to the present are summarized in Table I. He experienced attacks of urticaria/angioedema and elevated serum IgE levels in his subsequent life. He had no other recurrent infections.

A red-purple patch was observed on the right half of his face, beginning from the right upper lip and extending to the upper part of the right cheek to the right temple. This was diagnosed as capillary malformation. Erythematous and scaly patches were seen on the forehead, left arm, shoulder, back, trunk, upper chest, and thighs, respectively (Figs. 2a, 2b, and 3a). These lesions were diagnosed as ILC. Histopathological examination revealed psoriasiform dermatitis compatible with ILC. We did not observe any pathology on the patient's hair.

Genetic analysis was performed on a DNA sample from the patient to evaluate possible mutations. It is an important issue to evaluate the origin to differentiate whether this is de novo or parental. However, we were unable to make a family analysis because all family



Figs. 1a and 1b. Diffuse erythematous and scaly patches on the body and scalp during the patient's neonatal period.

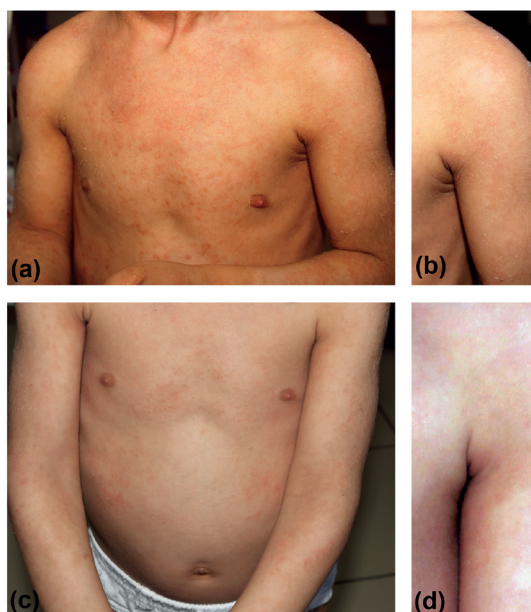
Table I. Clinical and Laboratory Summaries of the Patient from Birth.

Birth to age 1
E%: 14.5, IgE:1270 IU/ml
Normal results of: Biotinidase enzyme assay, Tandem MS, Cranial MRI, Fontanel and Abdominal USG
Skin biopsy: Psoriasiform dermatitis
Ophthalmological examination: Normal findings
DC: Collodion baby, Congenital Erythroderma, Capillary Malformation, Leiner syndrome
PIC: Eosinophilia and Dysgammaglobulinemia
1-2 years old
E%: 8.1, IgE:1780 IU/ml
FIPILI/ PDGFRA Mutation: Negative
Skin prick test: Positive reaction for hazelnut and egg white
DC: Atopic dermatitis, PIC: HIES? OS?
2-4 years old
E%:15, IgE:2750 IU/ml and E%:11.2, IgE:2690 IU/ml
Phadiatop Test: Elevated Serum Specific IgE for hazelnut and egg white
Anti-gliadin IgA: Negative, Anti-endomysial IgA: Negative
DC: Atopic dermatitis, PIC: HIES? OS?
4 years old to the present
E%:10.9, IgE:3420 IU/ml and E%:7.1, IgE:2700 IU/ml
SPINK5 mutation: Positive
DC: NS, PIC: NS

E: Eosinophil; DC: Dermatological consultation; PIC: Pediatric Immunology consultation; HIES: Hyper IgE syndrome; OS: Omenn syndrome; NS: Netherton syndrome

members refused genetic testing, and we did not obtain a skin sample to extract RNA. Sanger sequencing was applied to *SPINK5* (ENST00000359874.7, NM_001127698.1), which revealed a homozygous mutation c.2112+2T>A in the splice region of intron 22. Following molecular confirmation of the diagnosis of NS, we administered acitretin 0.5 mg/kg/day and topical moisturizers. Figs. 2C, 2D, and 3B show the significant beneficial effect of acitretin after one year.

All authors declare their consent for publication of the manuscript. An informed consent was received from the parents of the patient to publish photographs.



Figs. 2a. Diffuse erythematous and scaly patches (ichthyosis linearis circumflexa) on both the trunk and arms prior to acitretin treatment.

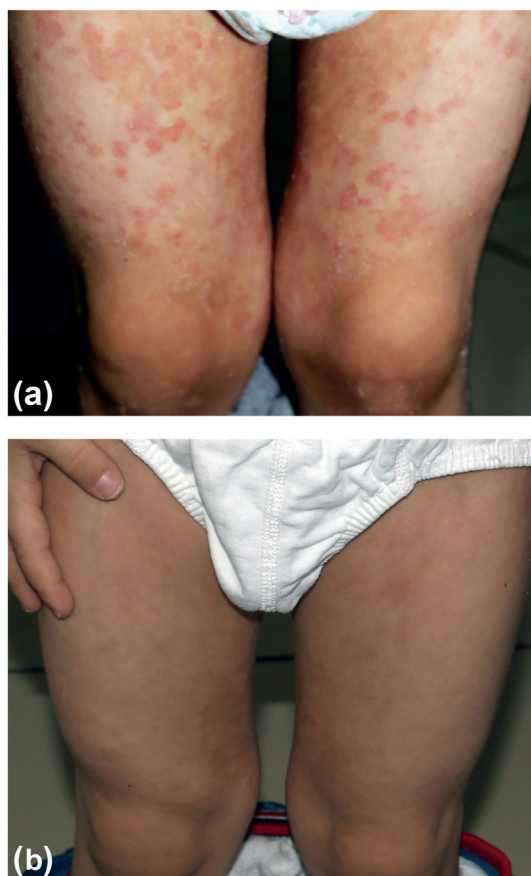
2b. Diffuse erythematous and scaly patches on both the left shoulder and arm prior to acitretin treatment.

2c. The same regions as in Figure 3A, after acitretin treatment.

2d. The same regions as in Figure 3B, after acitretin treatment.

Discussion

The mutation (c.2112+2T>A) was not previously described and is neither included in the Netherton registry *SPINK5*^{base4} nor in other data bases, including the 1000 Genomes Project, the Exome Aggregation Consortium, and the NHLBI Exome Sequencing Project. Because it affects the highly conserved second position of the splice donor site of intron 22, a deleterious effect can be expected. RNA samples from both the boy and his parents were unfortunately unavailable for further assessment of the pathologic mechanism. However, the Mutation Taster algorithm predicted this mutation as “disease causing,” which suggests that it may represent a further-thus far unknown-mutation underlying NS. Moreover, two other mutations that affect the splice donor site of intron 22 were described previously in families from German/



Figs. 3a. Diffuse erythematous and scaly patches on the thighs prior to acitretin treatment.

3b. The same regions after acitretin treatment.

Irish and Argentinian descent, respectively: c.2108_2117del10 and c.2112+1G>A.⁵ However, the Mutation Taster algorithm predicted this mutation as “disease causing,” which suggests that it may represent a further-thus far unknown-mutation underlying NS as it is likely to disturb normal splicing. In total, 84 different mutations of *SPINK5* have been registered in the Human Genome Mutation Database. Sarri et al.⁶ investigated 80 mutations that were previously identified in 172 patients from 144 families and demonstrated a wide variety of clinical phenotypes that are associated with these mutations.

HIES includes other autoimmune disorders and musculoskeletal system anomalies that have not been described in NS. Perivascular dermatitis in HIES is different from psoriasiform dermatitis in NS. Omenn Syndrome exhibits the absence of B cells and anomalous T cell

clones, which are not present in NS.^{2,3} Peeling skin syndrome, type B (PSS-B) shows similar features to NS; however, the clinical outcome is less severe, and the dermatopathology reveals perivascular dermatitis and subcorneal acantholysis.^{2,5} Severe dermatitis, multiple allergies, metabolic wasting syndrome (SAM) syndrome consists of metabolic wasting, gastroesophageal reflux, and minor cardiac defects, which are not compatible with NS.⁷ Enteropathy, hypoalbuminemia, and urinary extraction of glycine, histidine, and serine may be seen in NS.^{2,3} Metabolic tests, including blood levels of biotinidase enzyme, were conducted on our patient, and the results were normal (Table I). Wiskott-Aldrich syndrome includes thrombocytopenia and normal/low B and T cell levels.⁷

ILC is described as erythematous patches with two distinct features: It represents typically double-edged scales at the periphery of the lesions and it is migratory. ILC is rarely an isolated clinical manifestation; it is mostly included in NS with congenital ichthyosiform erythroderma, trichorrhexis invaginata (TI), and atopic manifestations.^{8,9} We examined ILC in our patient (Figs. 3a and 3b), and his parents described a migratory appearance of the lesions. Guerra et al.¹⁰ described two cases of ILC without congenital erythroderma, trichorrhexis invaginata, and symptoms of atopy and claimed ILC may be an isolated sign of NS. Hair anomalies, such as shorth and brittle hair and trichorrhexis invaginata, were absent in our patient, which highlighted the clinical heterogeneity of NS.

NS can represent urticaria/angioedema.¹ Attacks of urticaria/angioedema were reported in the medical files of our patient. Hazelnut and egg white allergies were defined via laboratory methods, which are summarized in Table I. In addition, we examined eczema in our patient during follow-up visits. Flare-ups of eczema and the need to use topical corticosteroids decreased after acitretin therapy. We found that both ILC and flare-ups of eczema improved during acitretin therapy; however, attacks of urticaria/angioedema did not. We did further consultations with the Department of Pediatric Nutrition and Metabolism, in which a low percentile of both height and weight were found. Whole blood counts, including

liver enzymes and blood lipid analyses, were assessed every three months, and no negative effect of acitretin was found.

Our case highlights that a genetic test can be critical for identifying NS. We cannot conclude that this is the definite disease-causing variant. Further investigations like the family genetic testing, and RNA testing are necessary to determine the variant as a mutation. The finding of underlying mutations contributes to the understanding of NS and is instrumental in indicating a specific therapy. Notably, treatment with acitretin has significantly improved both the ILC and eczema in our patient.

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