Epidermolytic Ichthyosis Sine Epidermolysis–A Case Report and Molecular Analysis

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Abstract:
Epidermolytic ichthyosis (EI) is a rare genodermatosis disorder. We report a 39-year-old woman with EI, who presented with generalized erythroderma since birth, followed by generalized hyperkeratosis later in life. The physical examination revealed generalized hyperkeratosis without blistering or erosion. The histopathological studies revealed hyperkeratosis with parakeratosis and psoriasiform hyperplasia, without significant epidermolysis. The Sanger sequencing revealed a missense mutation—c.467G>A (p.Arg156His)—in the KRT10 gene, confirming the diagnosis of EI. The genotype-phenotype correlations in EI patients are multifactorial. Thus, molecular analysis can confirm the diagnosis in cases of an unclear medical history or histological inconclusiveness.

Keywords: bullous congenital ichthyosiform erythroderma, epidermolytic hyperkeratosis, epidermolytic ichthyosis, KRT10, p.Arg156His
Introduction

Epidermolytic ichthyosis (EI), formerly known as bullous congenital ichthyosiform erythroderma of Brocq, is a rare type of genodermatosis that affects approximately 1 in 200,000–300,000 people worldwide. The disease is characterized by congenital ichthyosiform erythroderma at birth, which is frequently accompanied by blistering, peeling, or erosion. Later during infancy, it is also followed by hyperkeratosis and thickened skin, especially around the joints. Its pathogenesis is widely known and is caused by heterozygous mutations in the genes KRT1 and KRT10, which encode keratin 1 and 10, respectively, and are inherited in an autosomal dominant manner with complete penetrance. Sporadic mutations, which occur in 50% of these genes, have been associated with the development of EI-patterned cutaneous mosaicism on the lines of Blaschko. The characteristic histologic features are epidermolysis of the suprabasal and granular layers and epidermolytic hyperkeratosis (EHK). We present a case of generalized hyperkeratosis in a woman clinically and molecularly diagnosed with EI.

Case Report

A 39-year-old woman presented with generalized erythroderma and desquamation since birth. Later in life, she developed generalized marked hyperkeratosis without palmoplantar keratoderma. The patient and her parents had no history of skin blistering at birth. The affected skin was thick and darkened, and accentuated creases had formed over time. She was unable to fully extend her fingers and toes. To her knowledge, she had no family history of similar skin conditions. Physical examination revealed generalized scaly hyperkeratotic plaques over the face, trunk, and extremities, with skin crease accentuation over the joints and body folds. There were no blisters, erosion, or ectropion/eclabium on the periorificial skin.

Figure 1 Epidermolytic ichthyosis. (A–D) Widespread scaly brownish hyperkeratosis and multiple lentigines are noted. (E–G) Contraction deformity affected fingers and toes.
Notably, multiple lentigines and pigmented lesions were observed in both sun-exposed and sun-protected areas. Flexion deformity affected the third to fifth fingers of both hands and the second to fifth toes of both feet (Figure 1). Histopathological examination of a skin biopsy specimen revealed hyperkeratosis with parakeratosis, psoriasiform hyperplasia, mild papillomatosis, and superficial perivascular lymphocytic infiltration; acantholysis or epidermolysis was not observed (Figure 2A). After obtaining informed consent, Sanger sequencing was performed, and a missense mutation, c.467G>A (p.Arg156His), in KRT10 was detected (Figure 2B), leading to the diagnosis of EI. The patient received 25 mg of oral acitretin daily, which improved skin thickening but not the contracture.

Figure 2 (A) Confluent orthokeratosis, regular acanthosis, and superficial perivascular lymphocytic infiltration. The area of intracytoplasmic vacuolization of keratinocytes is not clearly seen. Irregular and enlarged clumping of eosinophilic intracytoplasmic inclusions are noted (black arrow and insert). (B) Gene sequencing demonstrates a heterozygous missense mutation c.467G>A (black arrow) in exon 1 of KRT10, resulting in substitution with a histidine residue (p.Arg156His).
Discussion

Our report describes an unusual case of EI without a history of skin blistering. EI is an autosomal dominant inherited ichthyosis caused by mutations in the suprabasal keratin 1 and 10 genes. These keratins are co-expressed in the differentiated spinous and granular layers of stratified epithelia. KRT1 is abundant in palmar and plantar skin, but KRT10 is expressed less in these regions. Different expression sites of keratin 1 and keratin 10 result in some distinct clinical differences. Their functions are to maintain cellular integrity and provide mechanical strength to the epidermis. The mutations in KRT1 and KRT10 in EI result in the clumping of mutant keratin intermediate filaments leading to the collapse of the cell skeleton network and, eventually, the cytolyis of keratinocytes. Consequently, clinically severe blistering of the skin develops. Additionally, keratins 1 and 10 play a role in cell proliferation; thus, a deficiency in these keratins results in the development of hyperkeratosis. Moreover, their aggregation and clumping are cytotoxic to keratinocytes, and they have been shown to disrupt cell differentiation and the formation of the lipid permeability barrier of the epidermis. Therefore, a disturbance of the barrier function occurs, leading to an increased transepidermal water loss and bacterial colonization.

The histopathological symptoms of EHK are as follows: (1) keratin tonofilament perinuclear shell aggregation within suprabasal keratinocytes, (2) hyperkeratosis of the stratum corneum with focal parakeratosis, (3) hyperproliferation of basal keratinocytes, and (4) suprabasal keratinocyte degeneration. The histopathological examination in our case revealed no characteristic evidence of EI. Clinically and histologically, ichthyosis hystrix Curth–Macklin, non-bullous congenital ichthyosiform erythroderma, and other congenital ichthyoses were potential diagnoses.

To further confirm the diagnosis, we performed direct gene sequencing, which revealed a mutation in KRT10 (Figure 2B). This mutation resulted in the substitution of conserved arginine with a histidine residue at position 156 of keratin 10 (p.Arg156His). Notably, the arginine at position 156 of KRT10, which is located in the conserved region of the rod domain, is structurally important for filament assembly; thus, mutation at this point results in a severe phenotype. Mutations in other amino acids, which do not lie within highly conserved residues, show a less severe effect on the intermediate filament. Generally, mutations in KRT1 and KRT10 cause different phenotypes; for example, severe palmoplantar keratoderma occurs from a mutation in KRT1, but not in KRT10. However, differences in histological features have not been described. Eskin-Schwartz et al. reported a four-generation Russian family with localized symmetric hyperkeratotic lesions without blistering or skin fragility in individuals affected by a KRT10 mutation (c.1322G>C/WT); the disease was diagnosed as EI sine epidermolysis. Similar to our case, histological findings of the affected offspring showed small foci of intercellular separation in the spinous layer without evidence of gross acantholysis, despite the presence of a mutation affecting highly conserved regions of the rod domain.

The p.Arg156His mutation is reportedly common according to previous reports. However, large clinical variations have been observed. Syder et al. explored the correlation between EHK severity and the extent of the associated mutation. They discovered that two severe cases shared the same mutation, which changed a conserved arginine to histidine at the amino acid end of KRT10’s alpha-helical rod domain. This variant is associated with EHK severity, as evidenced by histological suprabasal cell degeneration and cytolysis. The same mutation caused the severe hyperkeratotic phenotype in our case; however, our patient had neither blistering nor acantholysis, which may be explained by the highly complex genotype-phenotype correlations in patients with EHK. The actual amino acid substitution is as important as the position of the mutation.
in determining the phenotype of the patient.\textsuperscript{6,8–10} To our knowledge, EI is inherited autosomal with complete penetration, and spontaneous mutations are also common. The absence of an affected family member suggested that the mutation appeared de novo in our patient.

**Conclusion**

We describe a case of EI without overt epidermolysis caused by a point mutation in exon 1 of the \textit{KRT10} gene. Although this genotype has been previously described as leading to severe epidermolysis, our patient demonstrated minimal cell–to–cell separation without overt acantholysis. Therefore, physicians should be careful when clinical signs suggest EI, but there is no obvious epidermolytic change. Molecular diagnosis can be important in confirming cases with an unclear history or inconclusive histologic findings. Early diagnosis and treatment provide favorable outcomes, particularly in cases of contraction deformities.

**References**