Acta Derm Venereol (Stockh) 1996; 76: 62–64.

Brittle and Sparse Hair with Normal Cystine Content Caused by Methionine Deficiency?

G. GOERZ[1], W. BEHRENS[1], M. MEGAHED[1], W. KUESTER[2], J. FOHLES[3], D. TSAMBAOS[4], G. NIKIFORIDIS[5] and C. BALAS[5]

[1]Department of Dermatology, Heinrich-Heine University of Düsseldorf, [2]Department of Dermatology, Philipps University of Marburg, [3]German Wool Research Institute, Techn. University of Aachen, Germany, [4]Department of Dermatology and [5]Department of Med. Physics, University of Patras, Greece

The unusual case of an 8-year-old girl with a hair disorder is presented, characterized by brittle, short and sparse hair. On polarizing microscopy the latter reveals a "tiger tail" pattern, whereas severe cuticular defects are detected on scanning electron microscopy. The patient's hair has a normal cystine content but is completely devoid of methionine and reveals distinct changes of its viscoelastic parameters. It is presently unknown whether the lack of methionine may be implicated in the pathogenesis of this hair disorder, which to the best of our knowledge has not been previously described. ***Key words: sulfur; cuticle; trichothiodystrophy.***

(Accepted August 28, 1995.)

Acta Derm Venereol (Stockh) 1996; 76: 62–64.

G. Goerz, Department of Dermatology, Heinrich-Heine University of Düsseldorf, Moorenstr. 5, D-40001 Düsseldorf, Germany.

CASE REPORT

The patient, an 8-year-old white girl, born at full term after a normal pregnancy, had at birth normal black hair. Several months later a generalized and complete hair loss occurred. At 3 years of age, growth of sparse, short and dry hair was observed on the scalp and other areas of the body.

Physical examination of the patient revealed an alert, oriented, well-developed girl with no evidence or history of photosensitivity. Her scalp hair was brittle, dry and very short, not exceeding the length of some millimeters; its density was slightly decreased (Fig. 1). Her eyebrows were short and sparse, whereas the growth of the eyelashes was almost normal (Fig. 2). The growth of the nails was unremarkable; dental and ophthalmological examination revealed no abnormalities apart from hypermetropia. The mother of the patient was born with normal hair. At the age of 3 years she had developed short and brittle hair at the occipital region. Hair growth improved at puberty and returned to normal during pregnancy.

On polarizing microscopy the scalp hair of the patient showed a "tiger tail" pattern, characterized by alternating dark and bright bands (Fig. 3). Severe cuticle defects were seen on scanning electron microscopy (Fig. 4); the cuticular cells were partially abraded and had irregular, broken borders and an abnormal surface. The viscoelastic parameters of the patient's hair were determined with a computer-assisted method. Ten hair specimens derived from the patient and 100 hair specimens obtained from 10 sex- and age-matched controls (10 from each control) were investigated. Modulus of elasticity (E_α), post yield slope (E_β) and the ratio of the energy dissipated and stored (S_{DIS}/S_{STOR}) during the 30% extension of the hair specimens of the patient revealed a statistically significant decrease ($p<0.001$), as compared to the controls (Table I). Analysis of hair amino acid composition (Table II) was performed according to the method described by Spackman et al. (2). Hair (50 mg) was hydrolysed with 5.7 N HCl containing 3 vol% thioglycolic acid, which reduces the methionine sulfoxide to methionine and inhibits the degradation of methionine. The concentration of cystine was increased, whereas that

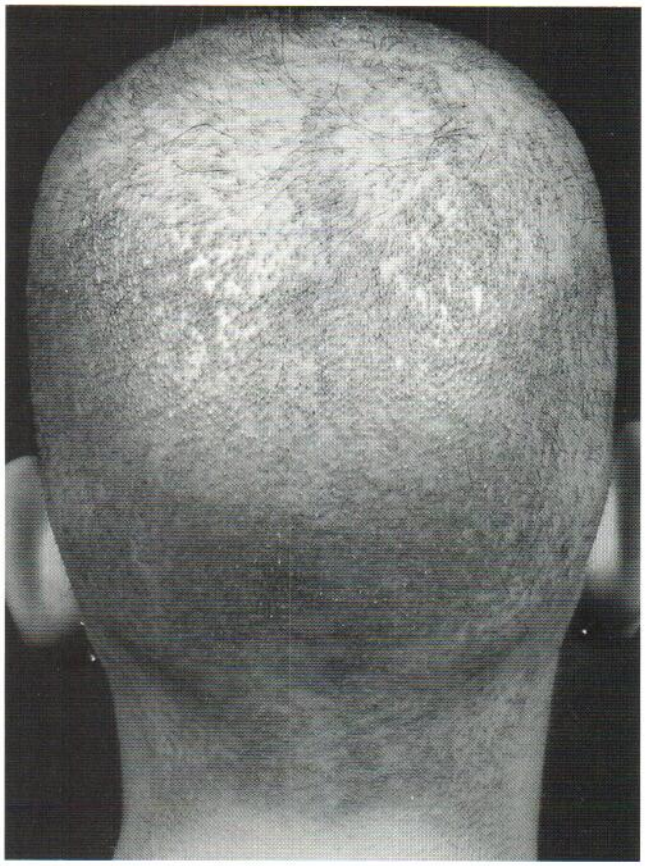

Fig. 1. Clinical aspect of the patient's scalp.

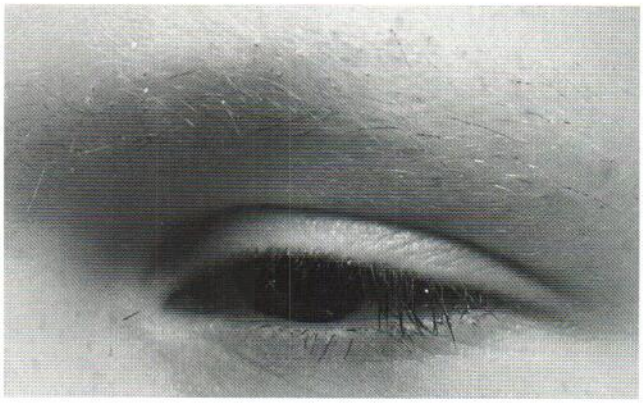

Fig. 2. The eyebrows are sparse and short; the growth of eyelashes is almost normal.

 ISSN 0001-5555

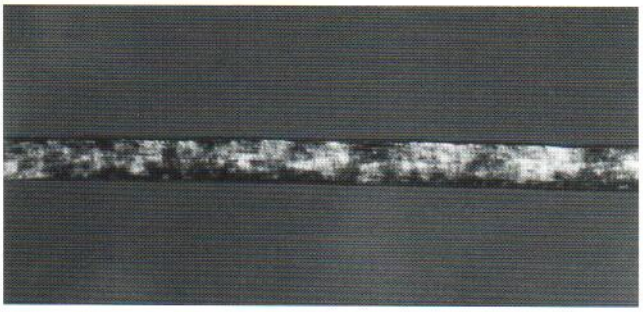

Fig. 3. "Tiger tail" pattern of the patient's hair on polarizing microscopy.

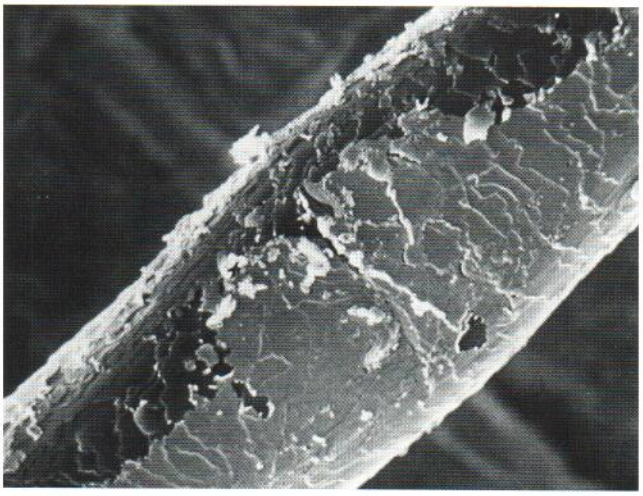

Fig. 4. Alterations of hair cuticle on scanning electron microscopy.

Table I. *Mechanical parameters of the patient's hair and of hair obtained from 10 sex- and age-matched controls*

NS = not significant.

Mechanical parameters	Units	Control hair ($n=100$)	Patient's hair ($n=100$)	$p<$
Modulus of elasticity (E_α)	GPa	5.89 ± 0.91	3.38 ± 0.47	0.000
Post-yield slope (E_β)	GPa	6.82 ± 1.07	3.87 ± 0.55	0.001
E_α/E_β	–	0.85 ± 0.04	0.86 ± 0.06	NS
S_{DIS}/S_{STOR}	%	81.23 ± 3.59	72.11 ± 2.95	0.001

of tyrosine was reduced in the patient's hair, as compared to the control; interestingly, no methionine or methionine oxides could be detected in the hair of our patient. The concentrations of all other amino acids were within normal limits. Finally, the urinary amino acid analysis revealed no abnormalities.

DISCUSSION

The clinical features of our patient's hair are identical to those occurring in trichothiodystrophy, a rare autosomal recessive hair disorder characterized by dry, brittle, short and sparse hair with low sulfur content (3). Moreover, alternating dark and light bands under polarizing microscopy, trichoschisis and absent or defective cuticle, which are regarded as important but not specific diagnostic clues for trichothiodystrophy (4), were evident in the hair of our patient. However, the diagnosis

Table II. *Amino acid analysis of hair obtained from the patient and from a sex- and age-matched control (the values are expressed in mol%)*

* Detection limit of the method: 0.1 nmol

Amino acids	Patient	Control	Normal values (9) (X±SD)
Lysine	2.64	2.81	2.5 ± 0.1
Histidine	0.84	0.97	0.9 ± 0.1
Arginine	6.53	6.11	6.2 ± 0.4
Aspartic acid	5.40	5.52	5.4 ± 0.1
Threonine	7.81	7.37	7.4 ± 0.1
Serine	12.23	12.12	11.6 ± 0.6
Glutamic acid	12.59	12.61	12.6 ± 0.7
Proline	7.00	7.27	8.4 ± 0.4
Glycine	5.55	5.63	5.8 ± 0.5
Alanine	4.61	4.75	4.5 ± 0.5
Valine	5.48	5.92	5.2 ± 0.5
Methionine*	–	0.54	0.4 ± 0.1
Isoleucine	2.65	2.90	2.4 ± 0.3
Leucine	6.64	6.69	6.5 ± 0.5
Tyrosine	0.96	1.55	2.1 ± 0.2
Phenylalanine	2.11	1.84	1.7 ± 0.4
1/2 Cystine	16.96	15.40	16.4 ± 1.4

of this disorder could be definitely ruled out, since the hair of the patient presented here revealed a normal sulfur cysteine residue content. On the other hand, ectodermal and neuroectodermal abnormalities which often accompany trichothiodystrophy, such as nail dystrophy, ichthyosis, ocular dysplasia, dental caries, mental retardation and photosensitivity (5), were not observed in our patient.

The cardinal feature of our case is the complete lack of methionine in the scalp hair of the patient. Methionine is an essential sulfur-containing amino acid that represents about 0.5% of the total amino acid content of normal human hair, whereas its levels in trichothiodystrophic hair are slightly elevated (4, 6, 7). Considering the normal urinary excretion of methionine and all other amino acids in our patient a systemic metabolic defect seems very unlikely.

The mechanical examination of the patient's hair revealed a decrease in the modulus of elasticity (E_α) and in the post yield slope (E_β), as a hint of a disordered arrangement of microfibrils within the matrix, very similar to that observed in trichothiodystrophy (3). However, in contrast to trichothiodystrophic hair, which is characterized by an increase in S_{DIS}/S_{STOR} (8), the hair of our patient reveals a marked decrease of this viscous parameter. This finding points towards an increase of disulfide cross-links and a decrease of hydrogen bonds in the keratin matrix. Nevertheless, it is presently unknown whether and how the lack of methionine alone or in combination with the other changes in the amino acid content of our patient's hair may be implicated in the pathogenesis of the clinical, mechanical and morphological features of the hair disorder presented here, which, to the best of our knowledge has not been previously described.

REFERENCES

1. Nikiforidis G, Tsambaos D, Balas C, Bezerianos A. A method for the determination of viscoelastic parameters of human hair in relation to its structure. Skin Pharmacol 1993; 6: 32–37.

2. Spackman DH, Stein WH, Moore S. Automatic recording apparatus for use in the chromatography of amino acids. Analyt Chem 1958; 30: 1190–1206.
3. Price VH, Odom RB, Ward WH, Jones FT. Trichothiodystrophy: sulfur-deficient brittle hair as a marker for neuroectodermal symptom complex. Arch Dermatol 1990; 116: 1375–1384.
4. Itin PH, Pittelkow MR. Trichothiodystrophy with chronic neutropenia and mild mental retardation. J Am Acad Dermatol 1991; 24: 356–358.
5. Van Neste D. Trichothiodystrophy: recent advances. Eur J Pediat Dermatol 1991; 1: 45–50.
6. Brown AC, Belser RB, Crounse RG, Wehr RF. A congenital hair defect: trichoschisis with alternating birefringence and low sulfur content. J Invest Dermatol 1970; 54: 496–509.
7. Gillespie JM, Marshall RC. A comparison of proteins of normal and trichothiodystrophic human hair. J Invest Dermatol 1983; 80: 195–202.
8. Tsambaos D, Nikiforidis G, Balas C, Georgiou S, Marinoni S. Trichothiodystrophic hair reveals an abnormal pattern of viscoelastic parameters. Skin Pharmacol 1994; 7: 257–261.
9. Baden HP. Hair keratin. In: Orfanos CE, Happle R, eds. Hair and hair diseases. Berlin: Springer, 1990: 45–71.