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IRON CONTENT IN NORMAL AND PSORIATIC EPIDERMIS

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Abstract. The iron content of normal epidermis and epidermis from untreated psoriatic lesions, as well as unchanged skin from subjects suffering from psoriasis, has been determined with the aid of neutron activation analysis. The mean iron content in normal epidermis is 26 μg/g dry weight and in unaffected epidermis from psoriatic subjects 30 μg/g dry weight. In epidermis from untreated psoriatic lesions the iron content is significantly greater, the mean content being 57 μg/g dry weight. The loss of iron via desquamation of normal epidermis is of minor importance in balance studies. In widespread scaling psoriasis the iron loss may be sufficient to cause iron deficiency.

By histochemically technique, the iron content of epidermis has been shown to be highest in the upper epidermal cell layers (8). Iron has also been demonstrated histochemically in both apocrine and eccrine sweat glands in considerable amounts (15). These findings have later been verified with the aid of autoradiography (18).

The loss of iron from normal skin has been stated by Bothwell & Finch (1) to be less than 1 mg per day and by Erdmann-Müller et al. (2) to be 0.5 mg per day.

Loss of iron can occur by desquamation of epithelial cells of the epidermis and glands of the skin as well as by secretion of sweat. The loss of iron via desquamation has been regarded as being the most likely major pathway since the iron content of cell-rich sweat is greater than that of cell-free sweat (6). In iron balance studies, however, both sweat and epidermal desquamation must be taken into consideration (17).

A selective distribution of iron in the epithelial cells of the epidermis and the sweat glands, in addition to evidence that iron accumulation in the epithelial cells may represent an active excretory process, have been postulated by Weintraube et al. (18).

Subjects with desquamating skin diseases, such as psoriasis, are consequently liable to lose considerable amounts of iron through the skin (8, 13). Anemia has been demonstrated in subjects suffering from psoriasis, not only in the more extensive conditions of the disease (14) but even in its milder forms. There is a relationship between the degree of anemia and the extent of the psoriatic lesions (10).

The aim of the present study is to use the highly sensitive neutron activation technique to investigate the iron content of normal and psoriatic epidermis as part of an investigation of the iron metabolism in psoriasis and thus be able to estimate the dermal loss of iron in normal and psoriatic conditions.

MATERIAL AND METHODS

Specimens of epidermis were obtained from 4 males free from any signs of skin disorders (age range from 19 to 57 years, mean age 33 years) and from 9 male patients with psoriasis from untreated plaques (age range 0–59 years, mean 46 years). Specimens from apparently normal unaffected skin were obtained from 5 of the psoriatic patients.

All the specimens were obtained from the middle part of the trunk in order to avoid variations of iron content in different regions of the body surface which has been reported as regards some other trace elements (11).

In all the cases the psoriatic plaques studied had been static for at least 1 month. The palpable infiltration of the lesions was considerable.

Separation of epidermis from dermis was performed by means of a method described by Kiistala & Mustakallio (7). Suction blisters was produced by applying a suction cup of the Dermovac® device. Pressure within the cup was maintained at 200 mmHg below atmospheric pressure. The required suction time averaged 120 min in untreated psoriatic plaques and 90 min in normal skin.

Table I. *Iron content of epidermis*

	Iron (μg/g dry weight)			
	Mean ± S.D.	Median	Range	*n*
Normal	26.53 ± 6.73	22.6	16.5–30.5	4
Psoriatic uninvolved	30.62 ± 12.46	34.0	17.0–46.4	5
Psoriatic involved	57.51 ± 26.32	55.4	27.5–97.8	9

Immediately after removal of the cup the roof of each blister was excised with a glass knife. The material (between 0.04 and 0.09 mg) was transferred directly with a glass rod to weighed quartz ampoules (5 mm diameter, 60 mm height). The ampoules with their wet content were weighed and then dried at 70°C for 3 hours, and at 110°C for the next 15 hours, and then weighed again.

Care was taken to reduce the risk of contamination at all stages of the sample preparation. The ampoules and glass instruments were cleaned before use by heating in *aqua regia* ($HCl + HNO_3$) and rinsing with demineralized water.

The ampoules were rapidly sealed by flame, and later irradiated together with standards in an atomic reactor R 2 at AB Atomenergi, Studsvik, with a thermal neutron flux of 2×10^{13} n/cm²/sec for 24 to 72 hours.

Chemical separation was performed by means of anion-exchange column and extraction chromatography.

The measurements of the activity were carried out by gamma-spectrometry. The quantitation of the activity was made by comparison with standards.

The radiation, separation, and measuring methods have been described in detail elsewhere (19).

The results were analysed statistically by the analysis of variance.

RESULTS

The mean dry weight as a percentage of the wet weight for normal epidermis was 17.5 ± 2.3%, for psoriatic unaffected epidermis 17.1 ± 2.2%, and for psoriatic affected epidermis 24.5 ± 3.1%.

The iron content of normal and psoriatic epidermis, both unaffected and affected, i.e. untreated psoriatic lesions, is given in Table I in μg/g dry weight.

No difference was found between the iron content of normal epidermis and that of unaffected epidermis, from psoriatic subjects. There was a significant difference between the iron content of untreated psoriatic epidermis on the one hand and of normal epidermis and unaffected epidermis from psoriatic subjects on the other ($F = 9.838$, $0.01 > p > 0.001$).

DISCUSSION

Some data concerning the iron content of normal whole skin is available from studies made some twenty to thirty years ago. Horster (5) and Magnusson & Raulston (9) reported 11 and 23 μg/g dry weight, respectively. Goldblum et al. (3) gave the iron content as ranging between 9 and 59 μg/g dry weight. There are few published investigations of the iron content of normal epidermis. Moore (12) has given the average iron content in normal epidermis stripped from 1 g of whole skin as being 1.44 μg/g (without specification of dry or wet weight).

Values of the content of trace elements in human tissue determined with the aid of spectrographic, photometric or colorimetric methods usually are much higher than those obtained by using more elaborate methods such as neutron activation analysis (19).

As far as the present authors are aware, no determination has been published of the iron content in psoriatic epidermis.

The iron content of epidermis in the present study is shown to be almost the same in normal skin and unaffected skin from subjects suffering from psoriasis. The iron content is, however, twice as high in the epidermis of untreated psoriatic lesions as in normal epidermis, when calculated on a dry weight basis. On comparison with normal epidermis and unaffected epidermis of psoriatic subjects, the difference is significant.

The oxygen consumption of the skin is greater in psoriatic lesions than in normal epidermis. Recently Hammar & Hellerström (4) have shown that the oxygen consumption in vitro was the same in basal parts of the epidermis of normal skin as in non-involved skin in psoriatics. In epidermis from guttate psoriatic lesions they found an increase in the oxygen consumption of 2.8 times.

A doubling of the iron content in untreated psoriatic lesions compared with normal epidermis was shown in the present study. The increase in oxygen consumption in psoriatic as compared with normal epidermis may indicate an increase of the mitochondrial oxidative activity. This finding also may indicate, either that in psoriasis

the mitochondria consist of more iron-containing oxidative enzymes, such as cytochrome C, than in normal epidermis, or that the content of mitochondria in psoriatic epidermal cells is higher than in normal epidermal cells.

0.5–1 g of the normal epidermis is desquamated per day (16). With an iron content in normal epidermis of 26 μg/g dry weight the average iron loss per day via desquamation is 10–20 μg. When compared with the total daily iron loss in the temperature zone of about 0.5–1 mg (1, 12), the iron loss via desquamation is thus of minor importance.

In psoriatic lesions the iron content increases, as shown in the present study. In generalized psoriasis with heavy scaling a skin loss of more than 10 g a day via desquamation has been described (16). With an iron content in psoriatic epidermis of 57 μg/g dry weight, up to 600 μg iron per day may be lost in this way. In most psoriatics the skin loss via desquamation is smaller. If the scaling occurs over a considerable period of time, however, the loss of iron via scaling in widespread psoriasis may be sufficient to result in iron deficiency. In most cases of psoriasis, however, the anemia found is not of iron-deficiency type but of chronic simple type (10).

Vellar (17) has recently given the mean concentration of iron in cell-rich sweat as 41 μg/100 ml, of which 30 μg was found in the cell-free fraction. These concentration figures are probably too high since they are based on studies of thermally-induced sweat in which the iron concentration was shown to decrease with increasing rate of sweat secretion. The mean normal loss of water from the skin is given by Shuster & Marks (14) as 0.43 mg/cm^2/hr which includes the transepidermal water loss. If the iron content in the water lost transepidermally is supposed to be the same as in the cell-free fraction of sweat, the daily iron loss due to water loss is calculated as about 70 μg per day, which exceeds the iron loss via desquamation about five-fold. In patients with psoriatic erythroderma the transepidermal water loss may increase ten-fold compared with that in normal subjects (14). If, again, the figures for iron concentration given by Vellar (17) are used, the iron loss via water loss in erythroderma could reach as high as 700 μg per day. Even though this calculated figure is probably too high, the importance of iron loss this way in psoriatic erythroderma cannot be overlooked.

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