Acta Dermatovener (Stockholm) 53: 477–480, 1973

COBALT, COPPER AND ZINC IN NORMAL AND PSORIATIC EPIDERMIS

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Abstract. By means of neutron activation analysis, the epidermal content of cobalt, copper and zinc has been determined in normal epidermis and in epidermis from untreated psoriatic lesions as well as from unaffected skin from subjects suffering from psoriasis. There is a significantly higher content of zinc in untreated psoriatic epidermis than in normal and uninvolved epidermis, and a significantly lower content of cobalt in untreated psoriatic epidermis. No difference is found in the content of copper. The calculated loss of the elements via desquamation is considered negligible in normal conditions but of possible significance as regards zinc and copper in extensive psoriasis.

Cobalt, copper and zinc are well known trace elements of biological function.

Cobalt is of interest, since it has recently been reported that an alteration of the vitamin B_{12} metabolism may occur in extensive psoriasis (4).

The role of copper in keratinization (11) has focused interest on copper in psoriatic skin.

Because of the demonstrated parakeratotic changes in domestic animals in zinc deficiency this element is of special interest as regards psoriasis, in which parakeratosis is such a characteristic feature (5, 10).

The aim of the present paper is to investigate, with the aid of a highly sensitive neutron activation analysis technique the content of cobalt, copper and zinc in normal epidermis and in epidermis from untreated psoriatic lesions as well as from unaffected skin of subjects suffering from psoriasis.

Neutron activation analysis gives accurate figures for the content of trace elements in the epidermis, thus allowing estimations of the role of skin desquamation in balance studies.

MATERIAL AND METHODS

Specimens of epidermis were obtained from 15 males, of whom 10 were suffering from psoriasis (age range 20 to 59 years, mean age 46 years) and 5 were without signs of any skin disorder (age range, 19 to 57 years; mean, 33 years).

All specimens were obtained from the trunk, thus avoiding variations in the content of metal elements in different regions of the body surface. No anaesthesia was used.

Separation of epidermis from dermis was performed using a suction blister method. Details of the separation and the method for the neutron activation analysis technique have been described previously (6, 15).

The results were treated statistically by analysis of variance.

RESULTS

The mean dry weight as a percentage of the wet weight for normal epidermis is $17.5 \pm 2.3\%$, for psoriatic uninvolved epidermis $17.1 \pm 2.2\%$, and for psoriatic involved epidermis $24.5 \pm 3.1\%$.

Table I gives the epidermal content of cobalt in $\mu g/g$ dry weight, in normal skin and in untreated psoriatic lesions as well as uninvolved skin from subjects suffering from psoriasis. There is no difference between the content in normal epidermis and in uninvolved psoriatic epidermis, but a highly significantly lower content in the untreated psoriatic epidermis as compared with normal and uninvolved psoriatic epidermis ($F = 13.584$, $p < 0.001$).

Table II shows the content of copper. There is no difference in the copper content between normal epidermis and uninvolved psoriatic epidermis or untreated psoriatic epidermis.

The epidermal content of zinc is given in Table

Table I. *Cobalt content in epidermis*

	Cobalt μg/g dry weight			
	Mean±S.D.	Median	Range	*n*
Normal	0.052±0.024	0.037	0.030–0.079	5
Psoriatic uninvolved	0.053±0.019	0.053	0.025–0.074	5
Psoriatic involved	0.023±0.015	0.016	0.008–0.049	10

III. There is no difference in the zinc content between the normal and unaffected psoriatic epidermis. There is a higher content of zinc in the involved psoriatic epidermis than in the normal and uninvolved epidermis ($F=21.948$, $p<0.001$).

DISCUSSION

In reporting the amounts of trace elements in biological materials, various investigators have used different bases of reference, e.g. wet weight, dry weight, ash weight, and nitrogen content. The use of different bases of reference has made it difficult to compare the results of the various investigators. In the present study the concentrations have been expressed on a dry weight basis. To facilitate comparison with other investigators the mean dry weight as a proportion of the wet weight is also given.

Cobalt

With spectrographic methods, Tipton & Cook (13) could detect cobalt in five out of 22 samples of whole skin. They thus estimated the cobalt content to be less than 2 μg/g of tissue ash (corresponding to 0.086 μg/g dry weight). Their findings are in agreement with the present results in which the range reaches up to 0.079 μg/g dry weight. This fact may allow of the conclusion that there is no essential difference between the cobalt content of normal epidermis and dermis.

Table II. *Copper content in epidermis*

	Copper μg/g dry weight			
	Mean±S.D.	Median	Range	*n*
Normal	3.76±0.83	4.2	2.6–4.6	5
Psoriatic uninvolved	4.35±0.57	4.3	3.7–5.1	4
Psoriatic involved	4.27±1.22	4.1	3.0–7.4	10

Table III. *Zinc content in epidermis*

	Zinc μg/g dry weight			
	Mean±S.D.	Median	Range	*n*
Normal	39.3±12.4	38.6	28.7–59.2	5
Psoriatic uninvolved	41.0±7.11	40.7	34.1–48.3	3
Psoriatic involved	90.8±48.2	66.3	46.6–198.7	10

The present study shows a higher content in normal epidermis and in uninvolved epidermis from psoriatic patients than in epidermis from untreated psoriatic lesions, the difference being highly significant (Table I).

The relevance of these findings in view of the reported vitamin B_{12} deficiency in extensive psoriasis (4) is uncertain.

Approximatively 0.5–1 g of normal epidermis is desquamated per day (12). With a mean cobalt content of 0.05 μg/g dry epidermis, the average cobalt loss per day via desquamation is about 0.02–0.05 μg. Thus the cobalt loss via desquamation is negligible as a source of error in cobalt balance studies, as compared with the cobalt loss per day via urine of 0.7 μg (16).

In generalized psoriasis with heavy scaling, a skin loss of more than 10 g a day via desquamation has been demonstrated (12). The maximal loss of cobalt per day via desquamation in untreated psoriasis can be calculated not to exceed 0.5 μg if the whole body surface is involved, which may be of importance as compared with the normal excretion and a possible source of cobalt loss in extensive scaling psoriasis.

Copper

The content of copper in the whole skin has earlier been estimated spectrographically by Goldblum, Derby & Lerner (2), Lipkin, Gowdey & Wheatley (3) and Tipton & Cook (13) (Table IV).

The values given by Tipton & Cook are in agreement with the figure for epidermis in the present study. The values given by the other cited investigators (Table IV) are far higher, as is often seen when results from neutron activation analyses are compared with results from earlier investigations made with other techniques (15).

In psoriasis, Lipkin, Gowdey & Wheatley (3) found an insignificant lower copper content in whole skin from psoriatic lesions as compared with uninvolved skin and normal skin.

With the aid of neutron activation analysis, Molokhia & Portnoy (7, 9) have recently stated a copper content in epidermis of normal skin (Table IV), which is higher than in the present study. They also investigated the copper content in psoriatic skin but could not find any difference between normal and psoriatic skin. This is in agreement with the results of the present study.

If, as earlier mentioned, the average epidermal loss per day is 0.5–1 g the average copper loss per day via desquamation is about 1.5–4 μg. The copper loss via desquamation is about one-tenth of the daily normal urinary excretion of 30–50 μg (16) and is of minor importance as a source of error in copper balance studies.

If the increased epidermal cell turnover rate is taken into account, the copper loss via desquamation in subjects with psoriasis with heavy scaling involving the whole body surface may rise to 40 μg per day, which is of the same magnitude as the daily normal urinary excretion and is thus a possible source of copper loss in extensive psoriasis.

Table IV. *Previous reports on copper in normal and psoriatic skin (dry in weight)*

n = normal, pu = psoriatic uninvolved, pi = psoriatic involved epidermis

Author	Content
Whole skin	
Goldblum et al. (2)	n 7.4–88 μg/g
Lipkin et al. (3)	n 61 ± 47 μg/g
	pu 60 ± 67 μg/g
	pi 41 ± 38 μg/g
Tipton & Cook (13)	n (120 μg/g$_1$ tissue ash)
	5.4 μg/g[a]
Epidermis	
Molokhia & Portnoy (7)	n 7.05 ± 3.06 μg/g
Molokhia & Portnoy (9)	n 7.34 ± 2.15 μg/g
	pu 7.06 ± 2.29 μg/g
	pi 7.50 ± 4.01 μg/g

[a] Calculated by the authors.

Zinc

Quantitative estimations of zinc in normal skin have been reported by Goldblum, Derby & Lerner (2) and Tipton & Cook (13) as regards whole skin, and Molokhia & Portnoy (8, 9) as regards epidermis. The published results are presented in Table V.

Table V. *Previous reports on zinc content in normal and psoriatic skin (in dry weight)*

n = normal, pu = psoriatic uninvolved, pi = psoriatic involved epidermis

Author	Content
Whole skin	
Goldblum et al. (2)	n 20–680 μg/g
Tipton & Cook (13)	n (1000 μg/g tissue ash)
	45.1 μg/g
Epidermis	
Molokhia & Portnoy (8)	n 70.5 ± 26.3 μg/g
Molokhia & Portnoy (9)	n 56.9 ± 10.0 μg/g
	pu 83.0 ± 26.2 μg/g
	pi 84.5 ± 29.9 μg/g
Voorhees et al. (14)	pu (11.4 ± 3.2 μg/g wet weight)
	66.7 ± 18.7 μg/g[a]
	pi (20.1 ± 8.1 μg/g wet weight)
	82.0 ± 33.6 μg/g[a]

[a] Calculated by the authors.

The figure for zinc content in normal epidermis in the present study is in close agreement with the value given by Tipton & Cook for normal whole skin but lower than the values given by the other cited authors.

The present study shows a statistically significant increased content of zinc in untreated psoriatic epidermis as compared with uninvolved and normal epidermis.

Voorhees et al. (14) also found a higher zinc content in involved psoriatic skin than in uninvolved.

Molokhia & Portnoy (9) found zinc levels in epidermis of involved psoriatic skin almost significantly higher than the content in normal epidermis although not different from that of uninvolved psoriatic skin.

In psoriasis, the plasma concentration of zinc has been described as normal or low. Voorhees et al. (14) have shown that there was no improvement of the psoriatic lesions after supply of zinc, contrary to what happens after supply of zinc to parakeratotic animals. This finding is more in agreement with the results of the present study of an increased zinc content in psoriatic lesions and not, as earlier was thought,

that there was a lack of zinc in psoriatic epidermis as a possible causal factor in its pathogenesis (1).

The average daily zinc loss in normal individuals via desquamation is about 15–30 μg, thus almost negligible as a source of error in zinc balance studies. If the whole body surface is involved in psoriasis with heavy scaling the average daily zinc loss via desquamation may be increased up to 900 μg, which is about twice the normal zinc excretion via urine (500 μg) (16) and is thus of importance in the development of hypozincaemia in extensive psoriasis.

ACKNOWLEDGEMENTS

This investigation was supported by grants from the Edvard Welander Foundation and Karolinska Institutet.

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Received February 23, 1973

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