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THE THICKNESS OF HUMAN SCALP: NORMAL AND BALD*

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ABSTRACT

The authors studied the thickness of the layers in both normal and bald scalps to determine the effect of aging on baldness.

In non-bald subjects, 1) each scalp layer changes with aging; 2) the most noticeable changes are in the layers that contain hair; 3) the condition of the galea is influenced by aging.

In bald subjects, 1) in early male pattern alopecia no changes occur in scalp thickness; 2) in advanced baldness, all skin layers except the galea exhibit definite thinning.

Some authors have suggested that male pattern alopecia (MPA) is an early sign of a progressive tendency to hair loss typical of aging primates (1, 2, 3).

In man both aging and baldness considerably alter the anatomy of the scalp (4, 5, 6, 7, 8) and, in the case of MPA, will bring about final hair loss.

The role of each process in causing scalp alteration is, therefore, difficult to evaluate.

This paper presents the results of an analysis, never undertaken before, of the thickness of each layer in the scalp of non-bald and bald subjects of different ages.

The findings show that aging does affect the scalp thickness in hairy subjects in a way which is different from that observed in subjects with MPA.

MATERIALS AND METHODS

Studies on dead subjects. In this part of the study, 22 male and 22 female cadavers were used. Most of these subjects had died in traffic accidents, of heart failure, apoplexy or other acute diseases. None of them had been dead for more than 24 hours before examination.

Independent of sex or age, all these cadavers had apparently normal hairy scalps in the area of the vertex, from which fairly equal sized, large skin specimens, including galea, were excised.

The skin specimens, immediately on excision and without stretching, were fastened to pieces of cork with pins and fixed in neutral 10% formaldehyde solution for 24 hours.

Next, they were put through a series of standardized dehydration and embedding procedures, then cut exactly parallel to the surface of the paraffin blocks and at three different constant angles to the first cut surface. Four sections from each block were chosen at random, mounted on the same slide, and stained with hematoxylin-eosin.

Total skin thickness and individual layers were measured with an ocular micrometer inserted in a 10× eyepiece, with different objectives according to the layer studied and the base micrometer scale. All measurements were taken either at the center of each section or near the right or left of the middle line in each section.

The boundary of each skin layer between the skin follicles was defined. 1) The epidermis: We measured the distance between the basal line at the tip of the dermal papillae and the highest point of the stratum granulosum, excluding the horny layer, and the distance between the tip of the basal line of the ridges enclosing the papillae and the above-mentioned point in granular layer. 2) The dermis, hypodermis, and galea: We measured the maximal and minimal distances between their upper and lower ends.

Studies on living subjects. In living subjects we examined the thickness of scalp layers in 19 male individuals between 16 and 59 years old (Mean 35 yrs.). Of these, 8 (7 of them 16 to 59; av. age 34) had a normal scalp (at least 85% of the hairs in a trichogram of the vertex were in anagen); 7 (all between 22–43, av. age 33) were affected by "initial" male pattern alopecia (MPA): they had a trichogram with more than 15% telogen-hairs (9) and clinical hair loss of types III or IV in Hamilton's classification; 4 (all 39–44, av. age 42) had "advanced" MPA. They had an apparently glabrous vertex as in clinical types VII or VIII (10).

Skin samples, obtained from the vertex of these subjects after local xylocaine-epinephrine anesthesia and by means of a 10 mm hand-punch, were processed within 5 hours, as in the histological procedure previously described.

Statistical analyses. The data obtained from the skin layers of the 44 cadavers were divided according to age into 5 groups each sex (Table I) and statistically analyzed.

An effort was made to eliminate the possible influence of the total skin thickness on that of each layer. Therefore, testing the difference among the 5 age groups, we used the analysis of covariance with the total skin thickness (which did not differ significantly) as independent variate. The reduction of the mean square of error due to the regression on this variate valuably increased the precision of the experiment (11, 12).

If the difference was significant, we calculated the parameters of the regression on the age and drew the regression curves.

With the analysis of covariance we tested the differ-

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TABLE I

Age (in months)		1–200			200–400			400–600			600–800			800–1000		
Layer	Sex	N	Mean	SEM	N	Mean	SEM	N	Mean	SEM	N	Mean	SEM	N	Mean	SEM
Epidermis	M	2	40.3	±12.250	6	71.0	±7.904	2	61.4	±5.100	5	57.0	±4.469	7	44.8	±5.138
	F	2	31.4	±5.300	5	65.8	±8.993	4	66.2	±3.689	3	54.5	±1.638	8	46.8	±3.830
Dermis	M	2	664.0	±89.200	6	1597.9	±70.806	2	1464.3	±126.349	5	1405.1	±93.615	7	1137.5	±152.277
	F	2	678.4	±59.456	5	1760.2	±76.039	4	1594.4	±72.432	3	1303.3	±100.211	8	1471.8	±67.953
Hypodermis	M	2	1293.4	±446.000	6	1801.4	±100.135	2	1928.9	±278.749	5	1927.5	±354.883	7	1848.7	±573.183
	F	2	1062.9	±215.549	5	2946.6	±510.721	4	2549.6	±96.632	3	1808.8	±253.196	8	2425.7	±340.139
Total thickness	M	2	2002.7	±547.450	6	3380.1	±157.016	2	3454.7	±410.200	5	3387.9	±430.792	7	3030.9	±703.330
	F	2	1822.8	±269.700	5	4774.4	±573.065	4	4210.3	±83.951	3	3499.9	±13.495	8	3944.3	±363.503
Galea	M	2	204.7	±14.600	6	1037.4	±61.991	2	1556.9	±360.900	5	1285.9	±182.600	7	870.1	±93.546
	F	2	152.0	±23.351	5	856.9	±91.514	4	919.9	±124.264	3	772.4	±77.872	8	606.7	±37.275

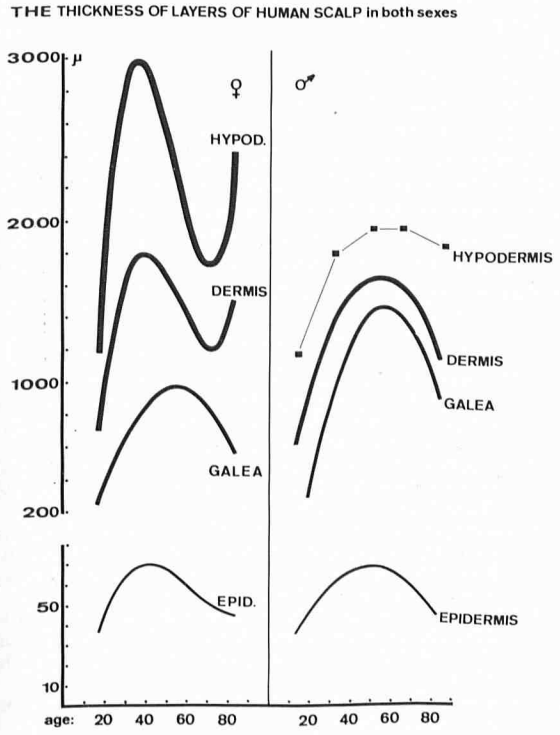

FIGURE.

ence between sexes as well, the independent variates being the age and the total skin thickness.

Finally, the data gathered from the 19 living subjects were divided into 3 groups: "normal", "initial" and "advanced"; the differences were tested with the analysis of covariance, the independent variate being the age.

RESULTS

In dead subjects. The results of microscope measurements, hereafter given in Table I and by a series of regression curves (Figure), were as follows: the thickness of *epidermis*, though similar in men and women, increased steadily up to 40 years in women and around 50 years in men and decreased thereafter.

The *dermis* was thicker in women than in men and reached its maximum around 35 years in women and around 55 in men. It then decreased in women up to the age of 70 and in men up to 80. However, a renewed rise was observed in females over 70. The *hypodermis* made up about 50% of the total scalp. This layer was also thicker in women than men. In men the thickness of the hypodermis did not undergo any statistically significant change with aging, as if no change was involved. In women, the thickness rose continuously and sharply up to the age of 32 or 33, then decreased until 70 only to rise again up to 85.

The *galea capitis* though considerably stouter in men than in women, became progressively thicker in both sexes up to the age of 55 and decreased thereafter until the age of 80 (see Figure).

When examined for statistical differences in relation to sex and age, the above data indicate (Table II) that the thickness of the epidermis varied with aging but not with sex; the thickness of the dermis varied with both sex and age; that of the hypodermis differed according to sex and varied in women with aging; the total thickness of skin, being influenced by that of the hypodermis, differed only with sex, whereas the thickness of the galea varied with both sex and age.

In living subjects. The results (Table III) of microscopic measurements, given in average micra, analyzed and corrected by covariance, were as follows: *In initial MPA*, no statistically significant variations in scalp layers were observed. *In advanced MPA*, a definite decrease in the values of *epidermis*, *dermis*, and *hypodermis* brought the thickness of each layer significantly lower than those in normal subjects, i.e. from about 24% to 44%. The *galea capitis*, did not reveal any change in thickness.

TABLE II

Skin layers	Statistical difference according to: Age	Sex
Epidermis	Highly significant	—
Dermis	Highly significant	Highly significant
Hypodermis	Significant (in females only)	Significant
Tot. thickness	—	Highly significant
Galea	Highly significant	Highly significant

TABLE III

Skin layers	Scalp thickness in Male Pattern Alopecia* Normal control (8 subj.)	Initial stage (7 subj.)	Advanced stage (4 subj.)	Statistical differences Normal control vs. Initial stage	Normal control vs. Advanced stage
Epidermis	71.57	64.89	53.34	—	Highly significant
Dermis	1847.73	1771.16	1404.82	—	Significant
Hypodermis	2364.93	2081.22	1324.26	—	Significant
Tot. thickness	4284.24	3917.27	2782.43	—	—
Galea	1116.52	1485.27	1102.50	—	—

* = means, in micra, corrected by covariance

DISCUSSION

Great care was taken to eliminate the possibility of error that may arise in this kind of study from post-mortem skin changes (13), artifacts induced by histological technique (14), and the lack of standardized procedure. This concern decided the choice of both dead and living subjects, the short interval (no more than 24 hours for cadavers; 5 hours for living subjects) which elapsed between the excision of the skin and the use of formaldehyde-fixed (14) specimens, and the homogenous handling of the material. Furthermore, our study was directed principally at obtaining comparative values within each group of subjects.

In dead subjects, previous data are confirmed by the decreasing thickness of scalp layers, with aging, especially after 40, as well as by the greater thickness of the female scalp (5, 6, 14, 15, 16, 17).

But the fact that the dermis is thicker in women than in men and also that the dermis and hypodermis in women over 70 is thicker than in earlier years, either conflict with other findings (14) or, as in the latter case, are quite inexplicable.

In living subjects, our findings of an unchanged scalp thickness during early MPA (18) and of a thinning out of the epidermis, dermis, and hypodermis in advanced MPA are supported by other data (4, 6).

In conclusion, changes in the thickness of scalp layers, including the dermis and hypodermis, i.e. the hair-containing layers, characterize both aging and baldness.

Since fibroblasts and adipose cells participate actively in dehydroepiandrosterone, testosterone, dehydrotestosterone and estradiol turnover in skin and hair follicles (19, 20, 21) dermis and hypodermis could well be the first skin structures to be subject to the hormonal, enzymatic, or other disturbances that may develop with aging and baldness.

In aging women, for example, the changes in dermis and hypodermis thickness coincide broadly with the curve of estrogen excretion during lifetime (22). This is an interesting coincidence in view of the recent finding (23) that the conversion of estradiol into estrone remains high, in the skin hair cycle, as long as the hairs are growing.

The characteristics of the galea capitis in aging and its unchanging thickness during MPA certainly do not support Schein's hypothesis, that alterations in hairy skin on the skull depend on changes in the galea (24, 25).

Aging and baldness, on the other hand, seem to influence scalp thickness in a different way: in aging men, the thickness of the hypodermis is probably unchanged; in bald men, the thickness of this layer probably remains steady in the initial stages of MPA while it drops sharply in the advanced stages to values which, although the comparison is risky, are lower by far than those observed in cadavers of the same age range.

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