ORIGINAL CONTRIBUTIONS

AGE-RELATED CHANGES IN THERMAL SENSORY THRESHOLDS OF SKIN

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Thermal sensory thresholds of 85 healthy subjects with normal height to weight range, and classified into five age groups between 10 to 60 years were measured and analysed statistically. Measurements were carried out with an electronic device at two different sites; forehead (FH) and finger-tip (FT), almost at constant (28-32°C) ambient temperature and relative humidity (60-65%). Since no significant sex difference was observed in any age group at either site, data for both sexes were pooled to compute the group means. The age groups showed different mean thermal sensory threshold levels which progressively increased with age at both the sites. The analysis of variance among the groups was found to be significant at 1% level for both FH and FT. While the data in groups 1 to 3 were relatively homogeneous, greater variability was found in groups 4 and 5. The threshold level, y, and the age group mean, x, could be related by an empirical equation $y=A+B \ln x$, where $A=30.85$ for FH and 27.82 for FT and $B=1.37$ for FH and 3.39 for FT.

Key words : Thermal sensory thresholds, Age-related changes.

Cutaneous aging may be either true aging which is the inevitable change in skin pre-ordained by time alone or photo-aging that includes changes attributable to deliberate insult of skin by exposure to sun.

By aging here, we shall mean true aging only. While a number of molecular events presumably underlie the aging process, it has not been possible to pin-point the mechanism(s) by which aging occurs in skin or, for that matter, in any other organ.[1] The age-related major macro-changes in the skin's appearance are roughness (dryness), wrinkling, laxity and a variety of benign neoplasms. But these changes are difficult to relate quantitatively to age for being used as aging index. Attempts were therefore made to see if the functions of human skin that decline with age could be so used. Sensory perception of skin is one of many such functions. Decreased sensory functions with age were documented[2] by several techniques such as optimal stimulus in gram for light touch, vibratory sensation etc. Cutaneous threshold to painful stimuli had also been reported to increase by upto 20% with advancing adult age.[3,4] But these techniques suffered from the limitations that these were at best semi-quantitative and were neither standardised nor had good reproducibility.

A method for a quantitative assessment of thermal sensory threshold (TST) by an electronic device is described here and it is discussed if the change in TST with age could be used as aging index.

Materials and Methods

Eighty five normal Bengalee subjects of both sexes and distributed over the age range 10 to 60 years constituted the sample population.

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Two different sites, the forehead (FH) and the right middle finger-tip (FT), were selected as test sites. Each subject was examined, prior to test, by a qualified dermatologist for any apparent skin lesion at the site.

The cutaneous thermal sensory threshold (TST) was determined by an electronic device[1] consisting of a testing probe, a control unit and a display meter. The probe is of circular cross-section, 5 mm in diameter, and is silver-tipped. It is connected to the control unit having an element of heating and a temperature sensor. The heater heats the probe to any pre-set temperature upto 70°C and the control circuit then constantly regulates the current to maintain the pre-set value within $\pm$1°C.

Starting from the room temperature, the probe was heated in steps of 1°C and touched briefly (<3 seconds) but firmly at the test site. The subject was instructed before-hand to signal immediately when he or she just distinctly felt the heat sensation. The probe temperature in degrees Celsius at which a subject just perceived the heat sensation was recorded from the digital display meter. This was the thermal sensory threshold (TST) of the subject at the site. The TST was recorded twice at each site, once while the probe temperature was increasing, the other whilst decreasing. The mean of the two readings was taken as the TST of the subject at the site concerned.

Prior to testing, the skin was brought in thermal equilibrium with the room temperature by exposing the test site for a period of at least 15 minutes. The test site was maintained dry and any undue pressure was avoided. Between any two successive contacts, at least 15-second interval was given to ensure that the tip temperature remained at the pre-set value.

The ambient temperature and the relative humidity were recorded during the experiment.

Results

The data for cutaneous thermal sensory threshold and the statistical analysis thereof are presented in tables I and II.

Table I. Analysis of variance of the TST on the :
A. Forehead.

Source	df	SS	MS	F
Sex	1	0.91	0.91	0.45
Age	4	40.02	10.00	4.97**
Interaction	4	18.98	4.74	2.36
Error	75	150.70	2.01	

B. Finger-tip.

Source	df	SS	MS	F
Sex	1	1.25	1.25	0.43
Age	4	65.28	16.32	5.67**
Interaction	4	20.00	5.00	1.73
Error	75	216.05	2.88	

df=degrees of freedom; SS=sum of squares
MS=mean square; F=F-ratio; ** $p<0.01$

Table II. Thermal sensory thresholds in different age groups,

Age group (Years)	Number of subjects	Values of TST at Forehead Mean(°C)	CV (%)	Finger-tip Mean(°C)	CV(%)
10—19	16	34.71	4.5	37.46	5.6
20—29	29	35.00	4.3	38.15	5.6
30—39	20	35.40	5.7	38.78	6.1
40—49	10	36.25	5.6	41.35	6.1
50—59	10	36.42	5.8	41.71	8.3

TST=thermal sensory threshold.
CV =coefficient of variation.

At both the sites there was a significant ($p<0.01$) age-dependence in the threshold values. However, no significant sex-difference existed at either site in any age group. Data for

both the sexes were therefore pooled to compute the group means (Table II). The age-groups at both the sites revealed different mean thermal sensory threshold levels which progressively increased with age. The lowest level was in group 1, 34.71°C for FH and 37.46°C for FT, and the highest was in group 5, 36.42°C for FH and 41.71°C for FT. Data in the lower age groups were relatively more homogeneous, the variations being small. A greater variability however was found in the higher age groups.

There was a significant ($p<0.05$) positive correlation ($r=0.83$) between the threshold values at the two sites. A strong and significant ($p<0.01$) positive correlation was also found between the threshold level, y, in degrees Celsius and the logarithm of the age group mean, x, expressed in years ($r=0.95$ for FH and 0.92 for FT). This is demonstrated in Fig. 1. The variables y and x can be related by an empirical equation of the type

$$y = A + B \ln x$$

where $A = 30.85$ for FH and 27.82 for FT and $B = 1.37$ for FH and 3.39 for FT.

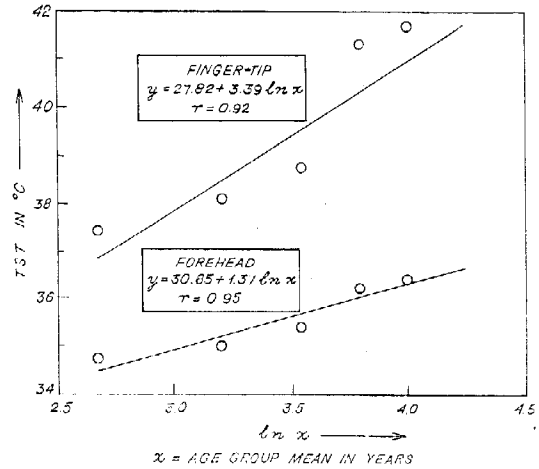

Fig. 1. Thermal sensory threshold of skin as a function of age group mean.

Comments

The reproducibility of the instrument used for the quantitative assessment of thermal sensory threshold has been tested and found to be quite satisfactory.

The significant positive correlation between the TST's of the two sites is rather expected for they are not quite independent, as they relate to the same individual. The increase in cutaneous threshold to thermal stimuli with advancing age may be due to a number of contributing factors. These may include increased rate of heat dispersion due to age-associated dermal changes such as elastic degeneration, age-related loss of vascular network, density distribution of cutaneous nerves etc. In any case, the increased TST's in the higher age group is related to aging of the skin and it is the detection of the age-related change, if any, that constitutes the very objective of the present study. Due to non-linear change in the dermis, the effect of aging process is highly subject-dependent and this accounts for the greater variability in the higher age groups.

Since the TST-level increases progressively in a linear fashion with the logarithm of the age-group mean, the age-related change in TST could be well utilized as an aging index, complementary to other indices of aging. The importance of generating data on age, sex and site-dependency of measurable parameters in studying the aging of skin and increasing the efficiency of skin treatment has been well brought out by Dikstein.[5] The method described here is a simple, straight-forward, quantitative and reproducible method of generating data in that direction.

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