Influence of age and hormone replacement therapy on the functional properties of the lips

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Aims: To investigate the influence of age and hormonal status on some functional properties of the lips of women.

Methods: Lips properties were measured and compared through four groups of women (young with normal menses, aged with normal menses, aged and menopaused, aged, menopaused receiving hormonal replacement therapy). The following parameters were recorded: sebum excretion rate on the forehead. On the lower lip: TEWL, mechanical damping, color, tactile acuity. Moreover, capacitance images of each lips were recorded and the mean capacitance measured.

Results: Changes in TEWL, mechanical damping and tactile acuity appear clearly linked to age while the increase in lip darkness could be due to hormones. Sebum excretion rate is also clearly linked to hormonal status. Surprisingly, no changes of lips capacitance were detected vs. age or hormonal status. This study confirms that upper lip is more hydrated than the lower one.

Conclusion: Most of the parameters measured on the lips have similar variations than the same parameters measured on the skin. Only sebum and color appear being dependant on the hormonal status.

Key words: menopause – age – lips – TEWL – capacitance – color – mechanical damping – tactile acuity

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Accepted for publication 26 May 2007

LIPS HAVE important physiological as well as sociological functions. They are a transitional tissue between face skin, with its appendages, and internal mucosa of the mouth. They have a peculiar histological structure varying from that of normal skin to normal mucosa. In fact, this structure is adapted to a variety of functions entailed by specific human needs e.g. speaking, drinking, eating, smiling, etc. (1) while interfacing with the environment. Hence lip tissue is subjected to repeated mechanical distortions and to all kinds of physical and chemical stress.

There are quite few objective data available on the functional properties of the lips that can be explained by at least two reasons: first, relatively few research teams have taken interest in lip properties up to recent years: second, the tiny and curved surface of the lip vermilion makes it difficult to use conventional noninvasive methods to get reliable data. Indeed, most of the sensors these methods are fitted with are larger-sized than lip. Some studies have however been published that shows a widening of lip micro-relief and decreased TEWL with aging (2, 3). More recently, age-related changes in geometrical dimensions of lips have been reported with resulting alteration of the levels of extensibility and contractibility (4). The same paper also demonstrates marked differences in the hydration level of the surface: the upper lip appears to be more hydrated than the lower one.

The aim of the present study was to investigate age-related variations of some functional properties of the lips using new noninvasive techniques most appropriate for lip area. Since hormones, and particularly the relative hypoestrogenism occurring after menopause, are supposed to significantly affect aging process (5), the hormonal status of the women taking part in the experiment was considered.
Materials and Methods

Volunteers
Volunteers enrolled in the study signed a formal consent agreement after being completely informed about the purpose and the methods used. Eighty female volunteers were included and split into four groups of 20 ± 1 subjects according to age and hormonal status (see Table 1). Group 1 was made up of normal young women. Group 2 included older premenopausal women with regular menses. Women in group 3 were menopausal since at least 1 year and group 4 consisted of menopausal women with hormonal replacement therapy (HRT) based on both estrogens and progestatives since more than 1 year. Length of time since menopause onset was the same in women of the two last groups.

Sebum
Sebum excretion rate (SER) was measured on the forehead using a ‘Sebumeter’ (Courage & Khazaka Electronic, Koln, Germany). The forehead of volunteers was cleaned with a mild detergent lotion at their arrival in the laboratory. The amount of sebum produced over 1 h was then measured and expressed in mg/cm².

SkinChip images/hydration
Hydration level of lips was assessed using the new capacitance imaging technique known as SkinChip method (6, 7). This method gives capacitance images of the surface of lip, the mean gray level (MGL) of which are closely but inversely correlated with normal capacitance measurement. A region of interest located on the most external part of the lips was arbitrarily chosen.

TEWL
Vapo-Meter SWL-2 (Delfin Technologies Ltd., Kuopio, Finland) was used to measure TEWL (8). It is a closed-chamber device, more suited to the mouth area where measurement is often disrupted by variations in air moving over. Measurement was recorded on the middle of the lower lip.

Ballistometer
A device marketed by Diastron Ltd., Andover, UK, was used. The device was applied to the right side of the lower lip. Three parameters characterizing lip elasticity were automatically recorded. Only Alpha parameter, which is independent of the exact positioning of the device with regard to the lip’s surface, was considered. Alpha parameter is closely linked to the viscosity or mechanical damping of skin (9).

Color measurements
A Chromameter CR 200 (Minolta, Osaka, Japan) was gently applied to the middle of the lower lip. Three measurements were recorded on each volunteer.

Tactile acuity
Tactile acuity was assessed using the ‘Two points Gap Determination’ (TPGD) as proposed by Stevens and Choo (10). This psychophysical method aims to determine the shortest distance between two points that can be perceived when a series of small plastic pieces with two legs are applied on the surface of the lip.

Statistics
Correlations between various recorded data and age were assessed using the Pearson test. For group comparison, variance analysis was carried out, followed by REGXQ test either on data or rank according to the normality of the distribution. According to the normality of the distribution, results are represented as median and interquartile range or mean and standard error.

Results
Sebum
No general linear regression was found between the amount of sebum produced over one hour and age. However group 3 was significantly lower (∑<0.01) than groups 1, 2 and 4, which showed similar level (see Fig. 1).

Hydration level (SkinChip images from lips)
No linear regression was found between MGL and age and no differences between the four
groups. However, there was a highly significant difference between the upper and lower lips ($P < 0.002$). MGL of upper lip was much lower than MGL of lower lip, which indicates that capacitance of the upper lip was higher than that of the lower lip (Fig. 2).

**TEWL**

As seen in Fig. 3, TEWL was markedly higher in young adults (group 1) compared with the three other groups, which were not significantly different ($P < 0.001$). However, a quite small difference was found between groups 1 and 4 ($P = 0.07$).

**Color**

$L^*$ was lower in group 3 compared with the three other groups ($P < 0.01$) which were similar (Fig. 4). A negative linear regression was found between $L^*$ and age ($P < 0.001$) while none was seen with the two other color components $a^*$ and $b^*$.

**Ballistometry**

The Alpha parameter measuring the mechanical damping coefficient increased with age. Linear regression coefficient, $R$, was 0.38 which, for $N = 80$, corresponds to $P < 0.01$. When data are compared between groups, no difference stood out between groups 2–4. If data corresponding to groups 2–4 are pooled, there is a difference between median values of group 1 and the three other groups ($P < 0.01$) (Fig. 5).
Tactile sensitivity (TPGD)
There was a positive linear regression between age and TPGD \( (R = 0.34, P < 0.02, \text{Fig. 6}) \). Comparison between groups showed that mean value in group 1 was significantly lower than in group 3 \( (P < 0.02) \). It was also lower than in group 4 but the difference was not strictly significant \( (P = 0.06) \).

Discussion
The study protocol involved four groups of population whereby two main questions can be addressed: Is there any changes in the lip properties vs. age? And: Is there any difference in the lip properties between female volunteers according to their hormonal status? It has been known for years that sebum production is controlled by levels of circulating hormones. Some papers have already shown that SER decreases with aging \( (11) \) and that menopausal woman taking estrogen and progesterone after menopause shows a 35% increase in SER \( (12) \). This increase would reflect the stimulatory effect of the progestagen component \( (13) \). In Fig. 1, SER in group 3 (menopausal females) is clearly lower than in nonmenopausal females of groups 1 and 2. This result illustrates that SER change is more likely related to hormones than to aging. Present results confirmed that females receiving HRT (group 4) have a 35–40% increase in SER compared with untreated females of group 3.

Concerning lips capacitance or hydration, results are quite clear: there is no change of the lips hydration level in relation to age. Although the role of estrogens on skin water content has been often quoted, most of the objective studies conducted to demonstrate this influence failed to reach statistical significance. \( (14–16) \). The difference in capacitance between upper and lower lips is also very clearly confirmed in this experiment. As shown previously,\( (4) \) the upper lip has a higher capacitance than the lower lip. Does this mean that lower lip would be less hydrated? Only a comparative study of the stratum corneum thickness between the two lips could allow the question to be answered.

TEWL results confirm the trend toward a decrease with aging as reported by Nagase et al.\( (2) \) in 101 Japanese women from 20 to 62 years of age. It is worth noting that our TEWL values are however, higher and more importantly, that no significant difference was noticed between results of groups 2–4. Although some trend toward a higher TEWL value is observed in the HRT group compared with the groups 2 and 3, no significant differences according to the hormonal status can be stressed. Decreased TEWL with aging has been shown long time ago \( (17) \) and suggested to result from a decrease in epidermal metabolism leading to the production of larger corneocytes. Such a mechanism could also be the cause of the progressive TEWL decrease on the lips with aging.

With regards to the lower lip color, we did not find any changes in \( L^* \) (Luminance) with aging. Only \( L^* \) in group 3 was found statistically lower than \( L^* \) in groups 1, 2 and 4 \( (P < 0.002) \). No changes were found as far as \( a^* \) and \( b^* \) are concerned. Menopause might result in a slight darkening of the lip, which HRT treatment could
prevent or correct. At our knowledge only one study addressed this question: it was reported that HRT treated women showed redder lips than untreated menopausal women (18). Our study only confirmed this result as for $L^*$ parameter.

From a mechanical standpoint, skin is considered as a viscoelastic material. It means that it has both elastic and viscous components. With aging the elastic component of skin strongly decreases (19) and the viscous one becomes progressively preponderant (20). In the lower lip, our result (Fig. 5) shows that the Alpha parameter that measures mechanical damping of the tissue, increases with age without any particular effects due to menopause and/or HRT (no differences between groups 2–4). This increase in lip viscosity probably parallels the decrease in skin elasticity in early menopausal females, as published by Pierard-Franchimont et al (21). According to these results, skin and lips appear to exhibit similar changes in mechanical properties with aging.

Lips are highly sensitive areas for both tactile and thermal stimuli. For example, compared with forearm skin, the shorter perceptible distance between two points in contact with the lip surface is about four times less (22). On skin, this distance increases with age on most of the body areas (10, 22), reflecting the progressive decrease in the density of certain mechanoreceptors with aging (23) and some hardening of the skin surface. Our results (Fig. 6) show the same decrease in the lip tactile acuity vs. age as skin. Once again, no statistical differences between groups 2–4 were recorded which indicates that hormones do not have a marked influence on this lip function.

This study about lips aging shows numerous similarities with skin. With aging, lips and skin become less elastic, less sensitive to tactile stimuli, less permeable to water vapor and slightly darker.

Results of the study also reveal that any ‘hormonal effect’ is most unlikely in age related changes in lip surface hydration, lip mechanical properties and lip tactile acuity. With regards to TEWL, there is a trend in group 4 i.e. in females with HRT, towards a slightly higher level than group 3. A larger group of volunteers would be needed to be able to confirm such a trend. The same comment can be made about lips color: only menopausal untreated females in group 3 show darker lips compared with the three other groups. Finally, a clear hormonal effect is confirmed on sebum excretion that decreases following menopause and is stimulated HRT, based on estrogen and progesterone supplementation, stimulates again sebum secretion.

There is no doubt that hormones markedly influence skin physiology (24), but time and environment also have profound effects that can hide or modulate changes in skin properties specifically those induced by hormonal changes.

References


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