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MORPHOFUNCTIONAL STATE OF THE SKIN IN WOMEN DURING GESTATION AND LACTATION AND ITS PROGNOSTIC VALUE FOR ASSESSING NEWBORN STATUS

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Abstract

This review presents a comprehensive analysis of the morphofunctional changes in the skin and its appendages within the "mother-child" system during gestation, lactation, and early postnatal maturation. The study examines physiological transformations driven by endocrine and immunological restructuring (hyperpigmentation, connective tissue alterations, vascular and glandular reactions), as well as specific dermatoses of pregnancy (atopic eruption of pregnancy, polymorphic eruption of pregnancy, pemphigoid gestationis, and intrahepatic cholestasis). Particular emphasis is placed on the dynamics of biophysical skin barrier parameters, including transepidermal water loss (TEWL), pH levels, and stratum corneum hydration. Based on current data, a high degree of autonomy in the formation of the neonatal epidermal barrier is demonstrated. The review underscores the necessity of a multidisciplinary approach to patient management to ensure the dermatological health and psycho-emotional well-being of both mother and child.

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Keywords: pregnancy, mother-child system, specific dermatoses of pregnancy, morphofunctional skin state, transepidermal water loss (TEWL), skin barrier function, newborn skin, melasma, intrahepatic cholestasis of pregnancy.

МОРФОФУНКЦИОНАЛЬНОЕ СОСТОЯНИЕ КОЖНОГО ПОКРОВА У ЖЕНЩИН В ПЕРИОДЫ ГЕСТАЦИИ И ЛАКТАЦИИ И ЕГО ПРОГНОСТИЧЕСКОЕ ЗНАЧЕНИЕ ДЛЯ ОЦЕНКИ СТАТУСА НОВОРОЖДЕННОГО

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Аннотация

В обзоре представлен комплексный анализ морфофункциональных изменений кожного покрова и его придатков в системе «мать – дитя» в периоды гестации, лактации и раннего постнатального созревания. Рассмотрены физиологические трансформации, обусловленные эндокринной и иммунологической перестройкой (гиперпигментация, изменения соединительной ткани, сосудистые и железистые реакции), а также специфические дерматозы беременности (атопические высыпания, полиморфная сыпь, пемфигоид и внутрипеченочный холестаз). Особое внимание уделено динамике биофизических параметров кожного барьера, таких как трансэпидермальная потеря воды (TEWL), pH и гидратация рогового слоя. На основе современных данных показана высокая степень автономности процессов формирования эпидермального барьера новорожденного и обоснована необходимость междисциплинарного подхода к ведению пациенток для обеспечения дерматологического здоровья и психоэмоционального благополучия матери и ребенка.

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Ключевые слова: беременность, система «мать – дитя», специфические дерматозы беременности, морфофункциональное состояние кожи, трансэпидермальная потеря воды (TEWL), барьерная функция кожи, кожа новорожденного, мелазма, внутрипеченочный холестаз.

Introduction

Pregnancy is a unique physiological process accompanied by pronounced immunological, metabolic, and endocrine restructuring of the female body (3, 6, 11). These adaptive mechanisms provide optimal conditions for implantation, prolongation of gestation, and antenatal fetal development (6). Systemic changes naturally affect the state of the skin and its appendages, making them a target for various morphofunctional shifts (3, 6). According to the results of specialized studies, specific cutaneous manifestations are recorded in 90–100% of pregnant women, ranging from physiological phenomena to the manifestation of severe pathological conditions (3, 9, 11).

A key link in maintaining skin homeostasis during this period is the functioning of a temporary endocrine organ—the placenta (9). The fetoplacental complex initiates the active synthesis of steroid hormones, in particular, pregnenolone and progesterone (9). Furthermore, the placenta produces bioactive sphingolipids that induce melanogenesis, and growth factors responsible for angiogenesis and tissue vascularization (9, 11). Hormonal fluctuations within the "mother–placenta–fetus" system determine structural changes in the skin barrier, which is objectified by the dynamics of transepidermal water loss (TEWL) and epidermal thickness (1, 7).

Immunological status during gestation is characterized by large-scale modulation of the cytokine profile. To establish immunological tolerance to fetal antigens, an induction of the Th2-dependent response (IL-4, IL-5, IL-10) occurs alongside the suppression of Th1-type cellular immunity (9, 10, 11). This "immunological compromise" accounts for the variability in the clinical course of dermatoses:

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from temporary remission of pre-existing diseases to their onset or exacerbation (10, 11).

The aim of this review is to systematize data on morphofunctional changes in the skin during the gestational period. The paper examines physiological transformations and specific dermatoses of pregnancy, including atopic eruptions, polymorphic eruption of pregnancy, and intrahepatic cholestasis (3, 10). Particular attention is paid to the correlation between the skin condition of the mother and child, the patterns of maturation of the newborn's epidermal barrier, and the influence of these factors on the patient's psychological status and quality of life (1, 5). A profound understanding of these processes is necessary for implementing an interdisciplinary approach in the practice of obstetrician-gynecologists, dermatovenerologists, and pediatricians (10, 11).

Physiological skin changes during gestation. Physiological changes in the skin are diagnosed in the vast majority of women (90–100%) and represent the result of adaptation to a new hormonal and metabolic status (3, 6, 11). Despite being within physiological norms, these manifestations are often accompanied by subjective sensations such as itching or aesthetic discomfort (3, 10).

The most common sign, identified in 87–90% of pregnant women, is hyperpigmentation (3, 6). Melanocytic activity is stimulated by increased levels of estrogens, progesterone, and melanocyte-stimulating hormone (9, 11). Estrogens initiate melanin synthesis, while progesterone promotes its deposition in epidermal and dermal macrophages, and placental sphingolipids further activate tyrosinase (9, 11).

Clinically, these changes manifest as melasma, recorded in 45–75% of patients, which is characterized by hyperpigmented patches on the face with typical centrofacial, malar, or mandibular localization (3, 6, 9, 11). Another characteristic sign is Linea nigra—a vertical line along the linea alba of the abdomen, manifesting predominantly in the second trimester (9, 11). Increased pigmentation of the areolae with the formation of a secondary darkening zone and

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hyperpigmentation of the genital area are also noted (3, 9). Existing melanocytic nevi and freckles during this period may increase in size and acquire a more intense color (9, 11).

Connective tissue changes. The transformation of connective tissue during the gestational period is most clearly manifested by the formation of striae (striae gravidarum), which develop in 70–90% of women, primarily in the third trimester (6, 11). The pathogenesis of these changes is driven by a combination of mechanical stretching of the dermis and systemic hormonal influence, particularly increased adrenocortical activity, leading to structural damage of the collagen framework and elastic fibers (9, 10, 11). In primiparous patients, striae rubra (pink-purple stretch marks) are more frequently verified, whereas in subsequent pregnancies, striae alba—white atrophic scars remaining from previous gestations—predominate (6, 11). The main areas of localization for these morphological defects are the anterior abdominal wall, breasts, and thighs (3, 11).

Vascular and glandular changes. High concentrations of estrogens and placental angiogenic growth factors stimulate vascular proliferation and the modulation of their permeability (6, 11). Characteristic vascular phenomena include palmar erythema, recorded in two-thirds of fair-skinned and one-third of dark-skinned women, as well as spider angiomas (telangiectasias) localized on the face, neck, and upper chest (9, 11).

The functional activity of the skin appendages also undergoes significant restructuring. The secretory capacity of the eccrine glands increases, often manifesting as hyperhidrosis and the occurrence of miliaria (9, 11). Conversely, apocrine gland activity decreases during this period, which may lead to clinical improvement in conditions such as hidradenitis suppurativa (9, 11). Sebaceous gland activity intensifies, reaching its peak in the third trimester, visualized by the enlargement of the areolar glands (Montgomery tubercles), which become more prominent (6, 9, 11). Objective biophysical measurements confirm these

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processes, recording a moderate increase in TEWL and an increase in epidermal thickness (1, 7).

Dynamics of biophysical skin parameters. The use of non-invasive biometric methods allows for the objectification of the influence of the gestational and postpartum periods on the functional status of the skin barrier (1, 7). Despite the absence of pronounced clinical symptoms in many cases, the recorded changes reflect the deep adaptation of the skin to hormonal and metabolic shifts (1).

A key marker of the integrity of the stratum corneum and its moisture-retaining capacity is the rate of transepidermal water loss (7). Studies have recorded a statistically significant increase in TEWL as gestation progresses: from the second to the third trimester, values increase on average from 9.5 to 13.8 g/m²/h (1, 7). Notably, the most pronounced disruption of barrier function is observed in the postpartum period, peaking two months after delivery (7). In some cases, TEWL values significantly exceed the physiological range, reaching 40–75 g/m²/h, which is attributed to sharp hormonal fluctuations during the body's transition to a non-pregnant state (7). Full restitution of the barrier function and normalization of TEWL values occur by the sixth month of the postpartum period (7).

Despite the dynamics of water loss, other critical barrier parameters demonstrate high stability. The skin surface pH level remains unchanged throughout pregnancy and after delivery, varying within a narrow range of 5.0–5.3 (1). This indicates the preservation of the "acid mantle" effectiveness and its protective properties (1, 7). The hydration level of the stratum corneum also does not undergo clinically significant fluctuations, which is likely due to the protective effect of high estrogen concentrations maintaining the water-binding capacity of the tissues (1).

The morphological characteristics of the epidermis and skin microrelief are also subject to direct modulation during gestation (1). There is a tendency toward increased epidermal thickness, resulting from hormonally induced fluid retention

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and enhanced cellular proliferation (1). Comparative analysis with control groups confirms significant epidermal thickening in pregnant women (1). Concurrently, a change in microrelief toward increased skin roughness (RA and RZ parameters) is observed, while stiffness and overall elasticity parameters remain relatively stable, indicating the high regenerative potential of the skin (1). Thus, the biophysical profile of the "mother–child" system is characterized by a transient decrease in skin barrier efficiency, which is fully compensated within six months after delivery (1, 7).

Specific Dermatoses of Pregnancy

Specific dermatoses of pregnancy represent a heterogeneous group of pruritic inflammatory skin diseases manifesting exclusively during the gestational period or in the early postpartum period (4, 10, 11). Unlike transient physiological changes, these pathological conditions are characterized by pronounced subjective discomfort for the mother and, in several clinical situations, are associated with serious risks to antenatal fetal development (3, 10). Over recent decades, approaches to the systematization of these diseases have been repeatedly revised; currently, the Ambros-Rudolph classification is recognized as the most relevant, identifying four main nosological forms: atopic eruption of pregnancy, polymorphic eruption of pregnancy, pemphigoid gestationis, and intrahepatic cholestasis of pregnancy (3, 10, 11).

Atopic eruption of pregnancy is the most common form of dermatosis, accounting for up to 50% of all cases of specific skin lesions during gestation (10, 11). This category combines previously differentiated conditions such as eczema of pregnancy, prurigo of pregnancy, and pruritic folliculitis of pregnancy (9, 10). The clinical picture is characterized by an early onset—in 75% of patients, eruptions are recorded in the first or second trimesters (10, 11). Morphologically, the process is presented by eczematous or papular elements with typical

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localization on the face, neck, and flexural surfaces of the limbs, which often correlates with elevated serum immunoglobulin E levels (9, 10, 11).

Polymorphic eruption of pregnancy, also known as pruritic urticarial papules and plaques of pregnancy (PUPPP), manifests predominantly in the third trimester, more frequently in primiparous women (9, 10). A pathognomonic sign of the disease is the primary skin involvement within the striae on the anterior abdominal wall, with strict sparing of the periumbilical area (9, 10, 11). The eruption may spread to the proximal parts of the limbs and the breasts; however, facial involvement is uncharacteristic for this nosology (10, 11).

Pemphigoid gestationis is a rare autoimmune bullous disease that develops in the second or third trimesters (10, 11). Unlike polymorphic eruption, the pathological process often manifests specifically in the umbilical region with the appearance of intense pruritus and urticarial plaques, rapidly transforming into tense bullae (9, 10, 11). Verification of the diagnosis requires direct immunofluorescence of a skin biopsy, revealing linear deposits of the C3 complement component along the basement membrane (10, 11).

Intrahepatic cholestasis of pregnancy is pathogenetically linked to impaired excretion of bile acids and is characterized by a specific clinical picture (9, 10). The leading symptom is agonizing pruritus without primary morphological elements, which traditionally begins on the palms and soles, intensifying at night (10, 11). The only objective signs on the skin are secondary excoriations caused by intense scratching (3, 10). The determination of the concentration of total serum bile acids is of decisive importance in diagnostics (10, 11).

The epidemiological profile of specific dermatoses demonstrates significant variability depending on geographical and ethnic factors. In regional studies in India, prevalence rates fluctuate from 2% in the south of the country to 5% in the northern states, while the structure of morbidity differs substantially: prurigo of pregnancy predominates in Kashmir, whereas intrahepatic cholestasis leads in Delhi (3, 4, 6). In European populations, atopic eruption (approximately 50%)

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and polymorphic eruption (21.6%) are the most frequently diagnosed (10, 11). The prevalence of cholestasis in Western countries is approximately 1 case per 100 pregnancies, while pemphigoid gestationis remains a casuistically rare pathology (4, 10).

The prognosis for the newborn is determined by the nosological form of the dermatosis. Atopic eruption and polymorphic eruption are considered benign conditions that do not exert a direct negative influence on fetal development (9, 10, 11). Conversely, intrahepatic cholestasis is associated with a high risk of severe obstetric complications. Elevated levels of toxic bile acids induce placental anoxia and depression of fetal cardiac activity, which significantly increases the incidence of preterm labor (up to 45%), premature meconium passage, and antenatal death (4, 10, 11). In severe forms of cholestasis, delivery at 36–38 weeks is the standard of care (11). Pemphigoid gestationis, although considered less dangerous, correlates with the risk of placental insufficiency, preterm labor, and the birth of infants with a weight below the gestational norm (10, 11). Additionally, transient vesiculobullous eruptions may occur in 5–10% of newborns due to the passive transplacental transfer of maternal antibodies (10, 11).

Psychoemotional and therapeutic aspects. Gestational and puerperal changes in the skin have a profound impact not only on the somatic status but also on the psychoemotional sphere of the woman (10, 11). The implementation of therapeutic strategies during this period is associated with the need to maintain a strict balance between clinical efficacy and the antenatal safety of the drugs used (9, 10). Given that over 90% of women encounter manifest skin changes, these conditions become a significant factor determining the patient's quality of life and self-perception (11).

Intense pruritus, pathognomonic for intrahepatic cholestasis and prurigo of pregnancy, acts as a powerful stressor, provoking persistent sleep disturbances and psychoemotional destabilization (3, 4). A particular psychological burden is

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associated with the pathology of skin appendages, specifically telogen effluvium in the postpartum period. It has been established that hair loss correlates with high rates of depressive disorders, social phobia, and anxiety states; moreover, the severity of psychological distress is often determined not by the objective severity of the process, but by the woman's individual coping strategies (5, 11). The inclusion of cognitive-behavioral therapy and mindfulness-based stress reduction (MBSR) practices in comprehensive patient management allows for a significant reduction in the level of affective disorders and improves treatment compliance (5).

Pharmacotherapy issues during gestation are strictly regulated by safety criteria, especially in the first trimester (9). When choosing antihistamines to relieve itching, priority is given to FDA Category B drugs, such as cetirizine, loratadine, and levocetirizine, due to the lack of evidence regarding their teratogenic effects in representative samples (9, 11). The use of Category C drugs (hydroxyzine, fexofenadine) is permissible only when the expected benefit outweighs the potential risks (9). Therapy for mild to moderate dermatoses (AEP, PEP) is based on the use of moderate-potency topical glucocorticosteroids in combination with emollients (6, 10). Severe forms of the disease, including pemphigoid gestationis, require the prescription of systemic corticosteroids under strict antenatal monitoring of placental function (9, 10).

Morphofunctional Maturation of the Newborn's Skin

The process of formation and maturation of the skin represents a dynamic continuum that persists throughout the first year of life (1, 2, 10). The morphological characteristics of the newborn's skin serve as an objective indicator of the child's biological maturity. The use of high-frequency ultrasound imaging (20 MHz) allows for the non-invasive verification of skin layer thickness, which demonstrates a direct correlation with gestational age at birth (10). Notably, epidermal thickness is an independent predictor of maturity,

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remaining stable regardless of the fetus's weight-to-height parameters or the presence of intrauterine growth restriction (10).

Functional adaptation of the skin to the extrauterine environment is characterized by the gradual formation of the "acid mantle" and the stabilization of barrier properties. In the neonatal period, there is a progressive decrease in the skin surface pH level, reaching values comparable to adult levels (4.9–5.0) by six months (1). Concurrently, the hydration of the stratum corneum stabilizes, and the skin microrelief smooths out, which clinically manifests as the regression of physiological dryness observed in the first days of life (1, 2).

During the first year of life, a significant evolution of the optical and biomechanical properties of the skin is observed. Skin color transforms from intense red hues—due to the superficial location of the microvascular bed—to lighter tones, with a gradual change in colorimetric parameters (2). The mechanical characteristics of the dermis also undergo qualitative shifts: the high viscoelasticity and pliability of early infancy skin are gradually replaced by more pronounced biological elasticity and resistance to deformation, reflecting the maturation process of the collagen-elastin framework (2). Despite the close pathogenetic relationship within the "mother–child" system, most parameters of the child's skin maturation are autonomous, highlighting the genetic determinism of these processes (1).

Relationship between the skin condition of the mother and child. The study of correlation dependencies between the functional skin parameters of the mother and the newborn demonstrated the absence of a clinically significant link for most key indicators (1). Detailed analysis of transepidermal water loss, stratum corneum hydration, and pH levels revealed no statistically reliable parallels between the skin characteristics of women during the gestational period and their children up to six months of age (1).

The identified spectrum of biophysical correlations is limited to a narrow set of properties: specifically, a moderate dependence was established between the

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mother's skin roughness parameters and the infant's skin stiffness and elasticity indicators (1). These results indicate a high degree of autonomy in the processes of postnatal skin maturation, which adapts to the extrauterine environment according to its own genetically determined biological program, independent of the functional status of the mother's epidermal barrier (1). In clinical practice, this dictates the necessity of perceiving the newborn's skin as a sovereign system requiring personalized therapeutic care focused on correcting the child's dryness or microrelief, regardless of the mother's dermatological profile (1).

Conclusion. The gestational period and the first months of postnatal life represent critical stages during which the skin undergoes intense physiological stress caused by endocrine restructuring and adaptation to a changing environment (1, 7). The performed analysis confirms that the vast majority of women encounter morphofunctional skin changes, the spectrum of which ranges from transient physiological phenomena to severe pathologies associated with risks to the fetus's life (10, 11).

In this regard, the implementation of an interdisciplinary approach to the management of pregnant patients appears justified (10, 11). The management of specific dermatoses and the correction of systemic changes require coordinated interaction between obstetrician-gynecologists, dermatovenerologists, and pediatricians (11). Coordination of specialist efforts allows for the timely verification of potentially dangerous conditions, such as intrahepatic cholestasis or pemphigoid gestationis, ensuring adequate antenatal monitoring and the selection of the safest possible therapeutic regimens (10, 11).

A fundamental aspect is the maintenance of the skin barrier function in the mother-child dyad (1, 7). Despite the relative stability of several parameters, objective data on the increase in transepidermal water loss and rising dryness indicate the expediency of the active use of emollients and specialized care products (1, 7). The use of these products contributes to the reduction of maternal

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skin roughness and the relief of xerosis in newborns, whose epidermal barrier is in a stage of active functional maturation (1, 2).

Given the proven autonomy of the child's skin development processes, therapeutic and preventive measures in pediatric practice must be strictly personalized (1). Furthermore, the integration of psychological support is a necessary component of patient management, contributing to the reduction of psychoemotional stress and ensuring overall well-being within the mother-child system (5).

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