THE ROLE OF ULTRASOUND EXAMINATION IN THE DIAGNOSIS OF ATOPIC DERMATITIS IN CHILDREN

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Abstract. *Atopic dermatitis (AD) is a chronic inflammatory skin condition characterized by impaired skin barrier function, immune dysregulation, and vascular changes, posing significant diagnostic and monitoring challenges. Recent advancements in high-frequency ultrasound imaging, Doppler ultrasonography, and shear-wave elastography have positioned ultrasound as a promising non-invasive tool for assessing structural and functional skin changes in AD. This article reviews the diagnostic value of ultrasound in evaluating epidermal and dermal alterations, vascularization, and tissue elasticity in pediatric AD patients. By analyzing data from clinical studies, we highlight how ultrasound complements traditional diagnostic methods, such as the SCORAD index, and supports personalized treatment strategies. The integration of ultrasound modalities enhances the understanding of AD pathogenesis and aids in monitoring disease progression and therapeutic efficacy.*

Key words: *Atopic dermatitis,SCORAD, Ultrasound examination,Doppler,SLEB.*

Introduction. Atopic dermatitis (AD) is a prevalent chronic inflammatory skin disease, particularly affecting children, with a significant impact on quality of life due to its association with other allergic conditions, such as bronchial asthma and allergic rhinitis [1]. The complexity of AD pathogenesis, involving immune dysregulation, skin barrier defects, and vascular changes, necessitates advanced diagnostic tools to assess disease severity and guide treatment [2]. While clinical scoring systems like SCORAD provide a standardized measure of disease severity, they rely on subjective evaluations of skin manifestations, which can introduce variability [1]. Non-invasive imaging techniques, such as dermoscopy and high-frequency ultrasound, have emerged as objective methods to visualize skin structures in vivo, offering quantitative data to support clinical assessments [5].

Ultrasound examination, utilizing high-frequency transducers (20–100 MHz), Doppler ultrasonography, and shear-wave elastography, enables detailed visualization of the epidermis, dermis, and subcutaneous tissues [2, 4]. These modalities provide insights into structural changes, inflammatory processes, and tissue elasticity, which are critical for understanding AD pathogenesis and evaluating treatment outcomes. This article synthesizes findings from recent studies to elucidate the diagnostic and monitoring potential of ultrasound in pediatric AD, with a focus on its ability to differentiate acute and chronic disease phases and guide therapeutic decisions.

Materials and Methods. The reviewed studies involved pediatric patients with AD, ranging from 0 to 18 years, diagnosed based on clinical criteria and the SCORAD index [1, 3]. Ultrasound examinations were conducted using high-frequency linear transducers (20–100 MHz) on devices such as Aplio 500 and SkinScanner DUB TPM, operating in B-mode, Doppler, and elastography modes [2, 3]. Key parameters measured included:

- Epidermal and dermal thickness (in micrometers, μm).
- Echogenicity (acoustic density, in arbitrary units, 0–255).
- Subepidermal low echogenic band (SLEB) thickness and echogenicity.
- Vascular density via Doppler ultrasonography.
- Tissue elasticity via shear-wave elastography.

Studies compared ultrasound findings in AD-affected skin with adjacent healthy skin, using a ratio coefficient (RC) to quantify differences [3]. Statistical analyses employed multivariate analysis of variance (MANOVA) and Student's t-test, with significance set at $p < 0.05$ [1, 3]. Data were collected from 128 AD patients and 40 healthy controls in one study [1], and 22 AD patients in another [3], alongside a cohort evaluated for innovative ultrasound techniques [2, 6].

Results.

Ultrasound Findings in Acute AD.

In acute AD, ultrasound revealed significant epidermal and dermal thickening, attributed to keratinocyte hyperplasia and edema [2]. The mean dermal thickness in active AD was increased by 20–40% compared to healthy controls [2]. Doppler ultrasonography demonstrated enhanced vascular density in affected areas, indicative of active inflammation and angiogenesis [2]. Shear-wave elastography showed reduced skin elasticity due to inflammatory edema, correlating with higher SCORAD scores [2]. The subepidermal low echogenic band (SLEB), a hallmark of inflammation, was consistently observed in affected areas, with thicknesses ranging from 89.3 to 125.87 μm and low echogenicity (2 arbitrary units) [3].

Ultrasound Findings in Chronic AD.

In chronic AD, ultrasound images displayed heterogeneous dermal structures with fibrotic zones and epidermal thinning due to prolonged inflammation and skin atrophy [2]. Doppler studies indicated reduced vascularization, reflecting diminished inflammatory activity [2]. Elastography revealed increased skin stiffness due to fibrotic remodeling, with reduced elasticity correlating with chronicity [2]. These findings distinguished chronic AD from acute phases, aiding in tailored treatment approaches, such as barrier repair versus anti-inflammatory therapies [2].

Therapeutic Monitoring.

Ultrasound proved valuable in assessing treatment efficacy. In a study of 22 children treated with a combination of 0.1% methylprednisolone aceponate cream, 0.03% tacrolimus ointment, and emollients, ultrasound scans after 4 weeks showed reduced epidermal thickness, increased dermal echogenicity, and diminished SLEB thickness, aligning with clinical improvement (SCORAD reduction from 58.6 to 21.3 in severe cases) [3]. The ratio coefficient (RC) approached 1, indicating normalization of skin structure [3]. Persistent SLEB in severe cases suggested residual inflammation, guiding extended therapy [3].

Clinical Correlations.

Ultrasound parameters correlated with SCORAD scores, with thicker epidermis and dermis, lower echogenicity, and increased vascularity corresponding to higher disease severity [1, 2]. The presence of SLEB in 62–100% of scans (depending on severity) highlighted its role as a marker of inflammation [3]. Elastography data indicated progressive elasticity loss in patients with frequent exacerbations, signaling a risk of chronic tissue remodeling [2].

Discussion. Ultrasound examination offers a non-invasive, repeatable method to assess ADrelated skin changes in real-time, overcoming the subjectivity of clinical evaluations [1, 5]. High-frequency ultrasound (20–100 MHz) provides high-resolution imaging (16–72 μm), enabling differentiation of epidermal and dermal layers, as well as subcutaneous structures [4]. The ability to quantify thickness, echogenicity, and vascularity enhances diagnostic precision, particularly in distinguishing acute inflammation (edema-driven) from chronic remodeling (fibrosis-driven) [2].

The SLEB, observed in both affected and adjacent healthy skin, is a critical indicator of subclinical inflammation, potentially predicting exacerbation risks [3]. Doppler ultrasonography and elastography further refine the assessment by quantifying vascular changes and tissue stiffness, respectively, which are pivotal in tailoring therapies [2]. For instance, increased vascularity in acute AD supports the use of anti-inflammatory agents, while fibrotic changes in chronic AD necessitate barrier-enhancing treatments [2].

Compared to dermoscopy, which visualizes superficial epidermal and papillary dermal structures [1], ultrasound provides deeper tissue insights, making it complementary in AD diagnostics [5]. Its non-invasive nature, lack of radiation, and ability to monitor dynamic changes position ultrasound as a superior tool for longitudinal studies [4, 3]. However, limitations include operator dependency and the need for specialized high-frequency equipment, which may restrict accessibility [4, 6].

Conclusion. High-frequency ultrasound, Doppler ultrasonography, and shear-wave elastography are transformative tools in the diagnosis and management of atopic dermatitis in children. These modalities provide objective, quantitative data on skin structure, inflammation, and tissue elasticity, enhancing the understanding of AD pathogenesis and supporting personalized treatment strategies. By correlating ultrasound findings with clinical severity (SCORAD) and monitoring therapeutic responses, clinicians can optimize patient outcomes. Future research should focus on standardizing ultrasound protocols and integrating these findings with immunological and histological data to further refine AD management.

REFERENCES

1. Abidov Kh.A., Khaitov K.N., Abidov A.M., Akhralov Sh.F. The role of ultrasound examination of the skin in the diagnostic assessment of the skin condition in atopic dermatitis in children / Pediatriya. 2024; 4: 687-697.

2. Fedorciv O. E., Mochulskaya O. M. New approaches to the diagnosis of atopic dermatitis in children. Ros Vestn Perinatol i Pediatr 2017; 62:(3): 99–104 (in Russ). DOI: 10.21508/1027–4065–2017–62–3–99–104.

3.Mikailova, D. A., and I. G. Sergeeva. "High-frequency ultrasound scanning as an objective method for monitoring therapy in the management of children with atopic dermatitis." Clinical Dermatology and Venereology 19.3 (2020): 429-436.4. Bezuglyy, A. P., et al. "Skin ultrasound examination in the cosmetologists practice." Vestnik dermatologii i venerologii 87.3 (2011): 142-152.

5.Polańska A, Silny W, Jenerowicz D, Knioła K, Molińska-Glura M, Dań- czak Pazdrowska A. Monitoring of therapy in atopic dermatitis — observa tions with the use of high-frequency ultrasonography. Skin Res Technol. 2015; 21:35-40. https://doi.org/10.1111/srt.12153

6.Yusupalieva, G., Khaitev, K., Akhralov, Sh. (2025). Innovative methods of ultrasound diagnostics in studying the pathogenesis of atopic dermatitis. Innovative Research in the Modern World: Theory and Practice, 4(4), 97–98. Retrieved from https://inlibrary.uz/index.php/zdit/article/view/66006.