ANALYSIS OF MORPHOLOGICAL TYPES OF HIV-ASSOCIATED TUBERCULOSIS IN THE CONDITIONS OF THE FERGANA VALLEY AND DEVELOPMENT OF A DIAGNOSTIC ALGORITHM

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Abstract. *This article examines the histological, immunohistochemical, and electron microscopic features of tuberculosis associated with HIV infection, focusing on late-diagnosed morphological forms. The study was conducted under the conditions of the Fergana Valley, where morphological changes were systematized according to the patients' immune status. The findings indicated cases characterized by granuloma regression, predominance of caseous necrosis, and imbalance of IL-10/TNF-α [1, 2]. The proposed diagnostic algorithm aims to improve early detection of HIV-associated TB and reduce delayed diagnosis cases [3].*

Objective and tasks of the study. The main objective of this study was to systematize the morphological types of HIV-associated tuberculosis identified at late stages, describe their pathogenesis based on immunohistochemical markers, and develop an early diagnostic algorithm [4].

Materials and methods.

The study was carried out during 2021–2024 at the Fergana Regional Phthisiatry and AIDS Centers [5]. A total of 90 patients diagnosed with HIV-associated tuberculosis were examined. Based on the immune status, patients were divided into three groups: CD4>350/µL (mild), CD4 200–350/µL (moderate), and CD4<200/µL (severe immunosuppression). Clinical, social, and laboratory factors were analyzed comprehensively [6].

Histological, immunohistochemical (IHC), and electron microscopic analyses were performed on biopsy and autopsy samples of lung, lymph node, and liver tissues [2]. Tissues were stained with H&E and Ziehl–Neelsen methods, and granulomatous inflammation, epithelioid cell count, presence of Langhans giant cells, and degree of necrosis were scored on a 0–3 scale. The results were statistically analyzed using SPSS v.26 ($p<0.05$) in correlation with clinical data.

Immunohistochemical studies were carried out using CD68, TNF-α, IL-10, IFN-γ, and anti-MTB markers [1]. Electron microscopy revealed mitochondrial, lysosomal, and nuclear alterations in alveolar macrophages. Pearson correlation analysis was used to assess relationships between CD4 levels, immunomarker expression, and morphological changes [4].

Results and discussion.

The results demonstrated that with increasing immunodeficiency, classical granulomatous inflammation diminished, while diffuse necrotic alterations became predominant [3]. In patients with CD4>350/μL, well-formed granulomas were observed, whereas in those with CD4<200/μL, granulomas were fragmented or absent. Langhans giant cells were not detected in 70% of cases [2]. TNF-α expression decreased and IL-10 levels increased, indicating enhanced immunosuppression [1]. CD68 expression confirmed the preservation of macrophages, although their phagocytic activity was reduced [6]. Electron microscopy revealed mitochondrial swelling (46%), endoplasmic reticulum dilation (39%), and phagolysosomal dysfunction (42%) in macrophages [4].

Environmental factors in the Fergana Valley — including dust, dry air, low temperatures, and high infectious load — were identified as regional contributors weakening the granulomatous response. These findings are consistent with reports in [1], [3], and [5].

The proposed diagnostic algorithm is structured as follows: morphological type and key immunomarkers correlate with immune status.

- In patients with CD4>350/μL, the granulomatous type predominates, characterized by elevated TNF-α and decreased IL-10, detectable through conventional histology.

- At CD4 200–350/μL, the necrotic type prevails; TNF-α declines while IL-10 increases, requiring additional IHC testing.

- When CD4<200/μL, the diffuse type is observed, with markedly low TNF-α and very high IL-10; in such cases, molecular diagnostics are recommended.

This diagnostic algorithm, integrating immune status, morphological type, and biomarker data, provides practical value in HIV-associated TB diagnostics [1, 2]. It contributes to optimizing pathological diagnosis and expanding early detection opportunities [4].

Conclusion.

HIV-associated tuberculosis manifests in three major morphological types: granulomatous, necrotic, and diffuse [1]. Reduction of CD4 lymphocytes is accompanied by granuloma regression, elevated IL-10, and decreased TNF-α levels [3]. These changes indicate immune imbalance, macrophage dysfunction, and cellular-level disruption [6]. The proposed diagnostic algorithm enhances early identification of HIV-associated TB under regional conditions, reduces late diagnosis rates, and improves treatment efficiency [5].

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