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DIAGNOSTIC SIGNIFICANCE OF THE Bcl-2 IMMUNOHISTOCHEMICAL MARKER IN ADENOID VEGETATIONS IN CHILDREN

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Abstract

Adenoid vegetations are among the most common upper respiratory tract disorders in children. The aim of this study was to investigate the expression of the Bcl-2 immunohistochemical marker in different morphological forms of adenoid vegetations and to evaluate its diagnostic significance. Adenoid tissue samples were examined using morphological and immunohistochemical methods. Bcl-2 expression was compared among different forms of adenoid hypertrophy. The highest expression was observed in the angiomatous form, whereas lower expression levels were found in the interstitial proliferative inflammatory and sclerotic forms. The findings suggest that Bcl-2 may serve as an additional diagnostic marker for the morphological assessment of adenoid vegetations.

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Keywords: Adenoid vegetations, children, Bcl-2, immunohistochemistry, adenoid hypertrophy, morphology, diagnosis.

Relevance of the Study

Adenoid vegetation is one of the most common disorders encountered in pediatric otorhinolaryngology. It predominantly affects children between 3 and 10 years of age, corresponding to the period of active development of lymphoid tissue. Enlargement of the adenoid tissue often results in impaired nasal breathing, habitual mouth breathing, sleep disturbances, and increased susceptibility to recurrent upper respiratory tract infections. Therefore, early identification of adenoid hypertrophy and a better understanding of its underlying pathogenic mechanisms remain clinically important.

The pharyngeal tonsil should not be regarded merely as a mechanical obstruction of the upper airway. As an integral component of Waldeyer's lymphatic ring, it plays a crucial role in the local immune defense by serving as the first immunological barrier against inhaled microorganisms. Following exposure to pathogens, lymphocytes become activated, immune cells proliferate, and local immune responses are initiated. However, prolonged antigenic stimulation may disrupt the physiological balance of immune regulation, resulting in persistent inflammation, lymphoid hyperplasia, and progressive enlargement of the adenoid tissue [1,2].

Routine diagnosis of adenoid vegetation is mainly based on endoscopic examination and conventional histopathological assessment. Although these methods provide valuable structural information, they do not adequately reflect the immunological alterations occurring within the tissue. Consequently, immunohistochemical techniques have gained increasing attention in recent years. Immunohistochemistry enables the detection of specific cellular proteins using selective antibodies, allowing precise evaluation of inflammatory activity, cellular composition, and the biological behavior of the lesion. This approach

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facilitates identification of pathological alterations that may not be evident by routine histological examination. Previous studies have demonstrated increased infiltration of both T- and B-lymphocytes in hypertrophic adenoid tissue, suggesting enhanced local immune activation. Moreover, variations in immune cell populations may be associated with differences in disease severity and clinical manifestations [3–5].

Persistent chronic inflammation is accompanied by significant changes in the expression of various immunohistochemical markers. Evaluation of these biomarkers provides a more comprehensive understanding of the biological processes occurring within hypertrophic lymphoid tissue. For this reason, combining immunohistochemical findings with conventional morphological examination substantially improves diagnostic accuracy. Among the biomarkers most frequently investigated in adenoid tissue are CD3, CD4, CD8, CD20, CD68, Ki-67, and Bcl-2. The expression patterns of these markers reflect the intensity of inflammatory reactions, lymphoid hyperplasia, cellular proliferation, and apoptotic activity, thereby providing important information regarding tissue remodeling and disease progression [6,7].

Accumulating evidence indicates that children presenting with similar clinical manifestations may exhibit remarkably different immunological characteristics within the adenoid tissue. These biological differences may partially explain the variability observed in disease progression and treatment outcomes. Several investigations have reported that the expression of immunological markers is considerably higher in patients with adenoid hypertrophy associated with allergic diseases, recurrent respiratory tract infections, or otitis media with effusion. Such findings further support the close relationship between local immune responses and the pathogenesis of adenoid hypertrophy. Current research is increasingly focused on integrating immunohistochemical biomarkers into routine clinical practice, particularly for improving early diagnosis and optimizing surgical decision-making [8–10].

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A comprehensive evaluation of immunological alterations within adenoid tissue contributes to a better understanding of the mechanisms underlying disease development and progression. Such knowledge may facilitate the identification of novel diagnostic biomarkers and support the development of more individualized therapeutic strategies. Therefore, immunohistochemical assessment of adenoid vegetation not only complements conventional morphological diagnosis but also provides valuable information regarding the biological activity and clinical behavior of the disease. In this context, investigation of the anti-apoptotic marker **Bcl-2** appears to be particularly promising for improving the diagnostic evaluation of pediatric adenoid hypertrophy and warrants further clinical and morphological research [11,12].

Objective of the study

To investigate the immunohistochemical expression of the anti-apoptotic marker Bcl-2 in different morphological forms of adenoid vegetation in children, to evaluate its association with pathological and morphological changes, and to determine the diagnostic significance of this marker in the morphological assessment of adenoid hypertrophy.

Materials and methods

This study was conducted at the Clinic of Andijan State Medical Institute between 2022 and 2025. A total of 42 children aged 1 to 8 years who were diagnosed with adenoid vegetation and underwent surgical treatment were enrolled in the study. Biopsy specimens obtained from the pharyngeal tonsil were subjected to histopathological and immunohistochemical examination. The study evaluated the age distribution of adenoid vegetation, the histopathological characteristics of the adenoid tissue, and the expression of immunohistochemical markers. Clinical findings were analyzed in conjunction with patients' medical histories to assess the relationship between morphological changes and clinical manifestations.

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Results

Morphological examination of adenoid vegetation demonstrated considerable heterogeneity in tissue architecture. While some specimens were characterized by marked enlargement of lymphoid follicles, others showed predominantly chronic inflammatory changes. Therefore, the immunohistochemical analysis was performed separately for each morphological pattern, allowing a comparative evaluation of immune cell activity among the different forms of adenoid hypertrophy. Particular attention was given to the expression of the anti-apoptotic marker Bcl-2, which plays an essential role in regulating apoptosis and maintaining cell survival. Consequently, its expression was considered an important indicator for assessing biological alterations within lymphoid tissue.

In the lymphoproliferative form of adenoid hypertrophy, the germinal centers were negative for Bcl-2 expression in almost all examined specimens. Only occasional sections demonstrated weak focal positivity. This finding suggests that active lymphocyte turnover and physiological selection processes remain preserved within the germinal centers.

In contrast, the mantle zones of the lymphoid follicles exhibited low to moderate Bcl-2 immunoreactivity. Positively stained cells were predominantly localized within the B-lymphocyte layer, indicating preserved cell viability and sustained functional activity of mantle zone lymphocytes. In several specimens, a distinct difference in Bcl-2 expression was observed between the germinal centers and the surrounding mantle zones. The absence or minimal expression of the marker in germinal centers, together with its relatively preserved expression in the mantle regions, indicates that different compartments of the lymphoid follicle undergo distinct biological processes. Overall, Bcl-2 expression was distributed unevenly throughout the lymphoid follicles. These findings suggest that, despite enhanced lymphoid proliferation in adenoid hypertrophy, physiological cell turnover and apoptotic regulation remain active within specific compartments of the lymphoid tissue (Figure 1).

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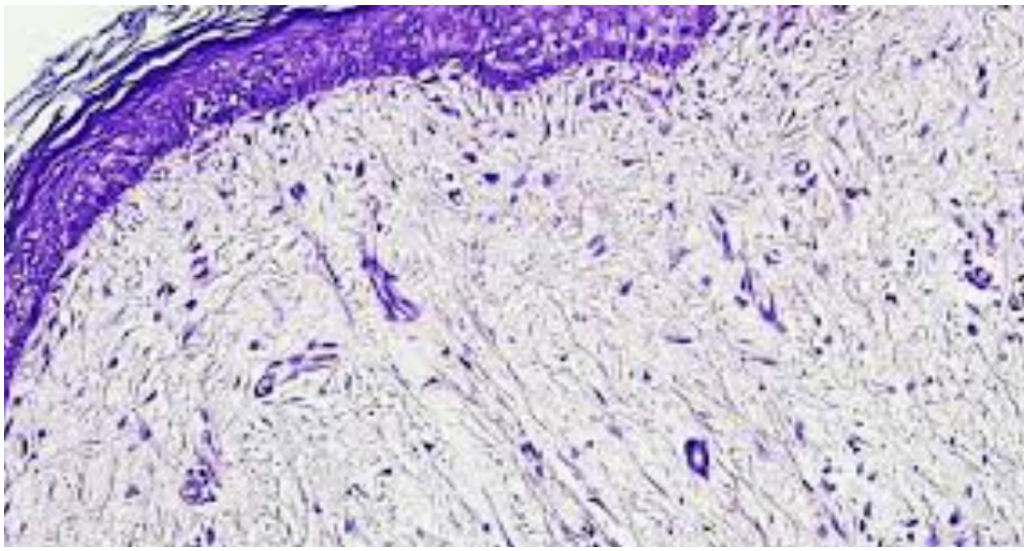

Figure 1. Weak immunopositive expression of the Bcl-2 marker around lymphoid follicles in adenoid tissue with lymphoproliferative hypertrophy. Immunohistochemical staining us

Interstitial proliferative inflammation was characterized by diffuse inflammatory infiltration of the adenoid stroma composed predominantly of lymphocytes and histiocytes. In the affected areas, increased cellular density was observed, with a relatively uniform distribution of lymphoid cells throughout the stromal tissue.

Immunohistochemical analysis demonstrated that Bcl-2 expression was mainly detected in a subset of lymphoid cells within the inflammatory infiltrate. Positive immunoreactivity was not observed in all inflammatory cells but was confined to small clusters of lymphocytes. In most specimens, the staining intensity was weak to moderate, while strong expression was not identified.

These findings indicate that the functional activity of lymphoid cells is heterogeneous under conditions of interstitial inflammation. Preservation of Bcl-2 expression in a proportion of infiltrating lymphocytes suggests that these cells remain viable and continue to participate in the local immune response. Conversely, the absence of Bcl-2 expression in many lymphoid cells indicates

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that physiological cell turnover and apoptotic processes are maintained within the inflamed tissue (Figure 2).

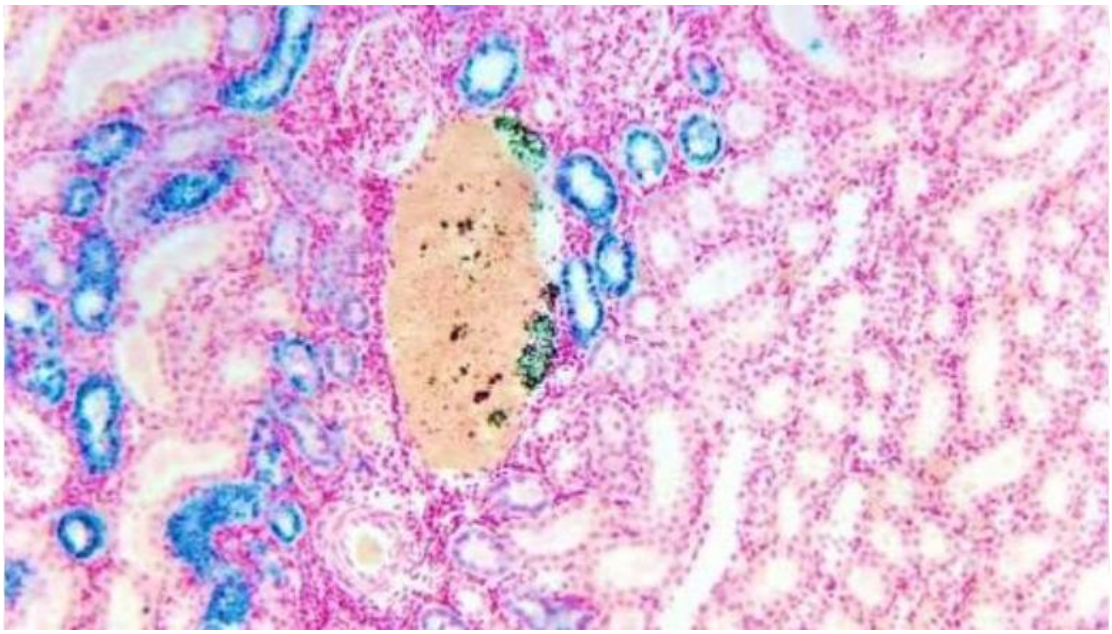

Figure 2. Bcl-2 expression was detected in a subset of cells within the lymphohistiocytic infiltrate of adenoid tissue with interstitial proliferative inflammation. Immun

In several specimens representing the interstitial proliferative form, thinning of the surface epithelium and focal atrophic changes were observed. The underlying lamina propria contained an inflammatory infiltrate composed predominantly of lymphocytes and histiocytes.

Immunohistochemical analysis demonstrated relatively strong positive expression of the Bcl-2 marker in a subset of lymphoid cells within the inflammatory infiltrate. The more pronounced Bcl-2 expression in areas of inflammatory cell accumulation suggests that these cells retain their functional viability and continue to participate in the local immune response. Furthermore,

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a relationship was observed between the epithelial atrophic changes and the pattern of Bcl-2 expression within the inflammatory infiltrate, indicating a possible association between tissue remodeling and anti-apoptotic activity in this morphological form (Figure 3).

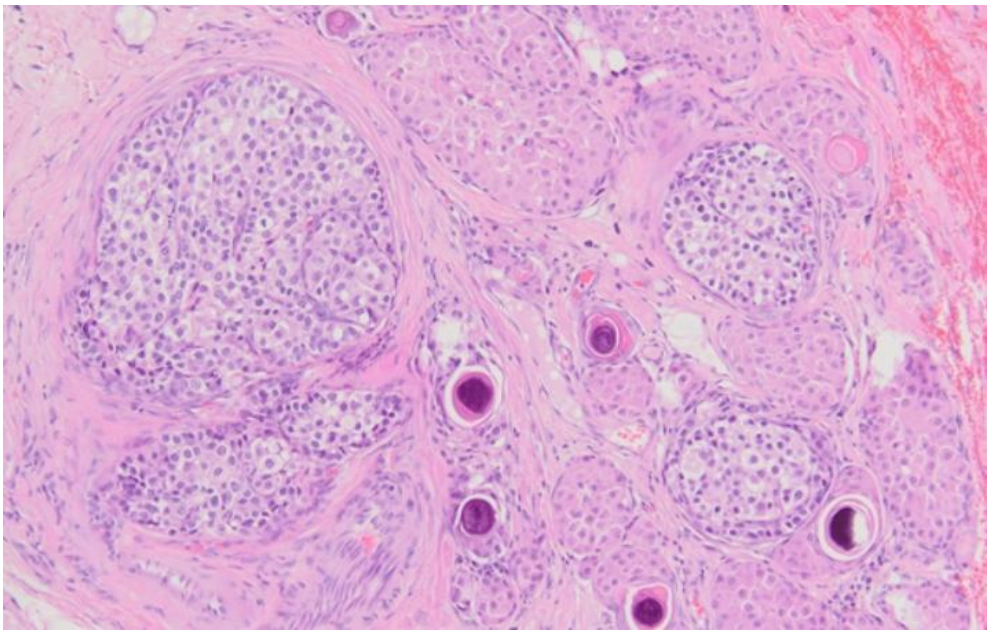

Figure 3. Moderate immunopositive expression of the Bcl-2 marker in lymphoid cells located between fibrous bundles in sclerotic hypertrophic adenoid tissue. Immunohistochemical staining using DAB chromogen. Original magnification: ×400.

Polymorphometric evaluation of the immunohistochemical staining demonstrated that the interstitial proliferative inflammatory form exhibited a moderate level of Bcl-2 expression. The mean proportion of Bcl-2-positive cells was 24.6%, indicating that although anti-apoptotic activity was preserved in this morphological form, its expression remained at a moderate level.

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Immunohistochemical examination of the angiomatous form of adenoid hypertrophy revealed morphological features distinct from those observed in the other groups. Prominent endothelial proliferation was accompanied by an increased number of pericytes and reticular stromal cells surrounding newly formed blood vessels. In addition, an increased density of lymphoid cells was observed. These findings indicate relatively active anti-apoptotic processes in the angiomatous form. Strong Bcl-2 expression was particularly evident in reticular stromal cells and lymphoid cells surrounding proliferating blood vessels, suggesting preservation of their functional viability. Polymorphometric analysis showed that the mean Bcl-2 expression in this group reached 68.2%, representing the highest level among all morphological forms included in the study. Immunohistochemical analysis of the sclerotic form of adenoid hypertrophy demonstrated a predominance of sclerosis and fibrosis within the tissue. Progressive deposition of connective tissue resulted in a reduction of the lymphoid component and a decrease in the number of lymphoid cells. The remaining lymphoid cells were mainly distributed between fibrous bundles. Overall, the findings demonstrated that Bcl-2 expression varied considerably among the different morphological forms of adenoid hypertrophy. The highest expression was observed in the angiomatous form, whereas the interstitial proliferative inflammatory form showed moderate expression, reflecting differences in the biological activity of the underlying pathological processes. In contrast, reduced Bcl-2 expression in the sclerotic form was associated with depletion of the lymphoid component and predominance of fibrotic changes. These results suggest that assessment of Bcl-2 expression, when combined with routine morphological examination, may serve as a valuable additional diagnostic marker for distinguishing the morphological forms of adenoid hypertrophy and evaluating the biological activity of the pathological process.

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Conclusions

1. The present study demonstrated that the expression of the Bcl-2 immunohistochemical marker differs among the various morphological forms of adenoid vegetation in children.
2. The highest level of Bcl-2 expression was observed in the angiomatous form of adenoid hypertrophy, whereas comparatively lower expression was detected in the interstitial proliferative inflammatory and sclerotic forms.
3. The findings indicate that Bcl-2 expression reflects the morphological changes occurring within adenoid tissue. Moreover, the level of marker expression varies according to the nature and biological activity of the pathological process.
4. Assessment of Bcl-2 expression in combination with conventional morphological examination may serve as a valuable additional diagnostic tool for identifying the morphological forms of adenoid vegetation and evaluating the activity of the underlying pathological process.

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