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Diagnostic Value of Laboratory Analysis in Sialolithiasis: A Comprehensive Review

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Abstract: Sialolithiasis is one of the most common obstructive diseases of the salivary glands. Despite advances in imaging techniques, early diagnosis remains challenging. This study aims to evaluate the diagnostic significance of laboratory parameters in sialolithiasis based on a comprehensive literature review. Biochemical, immunological, and microbiological changes play a crucial role in the pathogenesis of salivary stone formation. Increased calcium concentration, altered salivary proteins, and inflammatory mediators contribute to stone development. The integration of laboratory diagnostics with clinical and imaging methods improves diagnostic accuracy and allows early detection of disease.

Keywords: Sialolithiasis, Laboratory Diagnostics, Saliva, Biomarkers, Calcium Metabolism

Introduction

Sialolithiasis is one of the most common obstructive diseases of the salivary glands, accounting for approximately 50–60% of all non-neoplastic salivary gland pathologies [1,2]. The condition is characterized by the formation of calcified structures within the salivary ducts or glandular parenchyma, leading to partial or complete obstruction of salivary flow, recurrent inflammation, and functional impairment of the gland [1].

The pathogenesis of sialolithiasis is multifactorial and involves a complex interaction of local and systemic factors, including reduced salivary flow, changes in saliva composition, and inflammatory processes [2]. Biochemical imbalance, particularly increased calcium concentration and altered protein composition, plays a key role in the initiation and progression of stone formation

In recent years, increasing attention has been paid to the role of laboratory diagnostics in identifying early pathological changes in salivary gland diseases. Studies have shown that biochemical, immunological, and microbiological alterations in saliva and blood may precede clinical and radiological manifestations of the disease.

Significant contributions to the study of salivary gland diseases have been made by Uzbek researchers [3], [4]. In particular, Jumayev L.R. and co-authors demonstrated that reactive-dystrophic changes in salivary glands are associated with disturbances in clinical and laboratory parameters, reflecting impaired secretory function and saliva stagnation. Their studies also revealed that alterations in immune system parameters play an important role in the pathogenesis of sialosis and related conditions [5].

Furthermore, research conducted by Jumayev L.R. and Pulatova Sh.K. highlighted the diagnostic significance of glycoprotein composition in oral fluid. Changes in glycoprotein balance increase saliva viscosity and promote the formation of an organic matrix, which serves as a basis for mineral crystallization and stone formation.

Microbiological investigations by local authors have also demonstrated that changes in oral microflora contribute to inflammatory and dystrophic processes in salivary glands, further facilitating obstruction and stone formation.

Despite the availability of advanced imaging techniques such as ultrasonography and computed tomography, early diagnosis of sialolithiasis remains challenging [6], [7], [8]. In this context, laboratory diagnostics represents a promising complementary approach, allowing for a deeper understanding of disease mechanisms and early detection of pathological changes.

Aim of the Study

The aim of this study is to provide a comprehensive evidence-based evaluation of laboratory diagnostic indicators in sialolithiasis, to identify key biochemical, immunological, and microbiological markers associated with disease pathogenesis, and to justify their integration into a modern, multidisciplinary diagnostic framework for improving early detection, differential diagnosis, and clinical management of salivary gland disorders [9], [10].

Materials and Methods

This study was designed as a comprehensive narrative literature review aimed at evaluating the diagnostic significance of laboratory parameters in sialolithiasis. A total of more than 30 scientific sources, including both international and regional studies, were analyzed. Particular attention was given to: biochemical indicators (calcium, phosphate, proteins), immunological markers (cytokines, inflammatory mediators), microbiological findings (oral microflora, biofilms), salivary parameters (pH, viscosity, secretion rate)

The collected data were systematically reviewed and synthesized using comparative and descriptive analytical methods.

Methodological approach

The analysis focused on identifying consistent patterns and correlations between laboratory findings and the pathogenesis, diagnosis, and clinical progression of sialolithiasis.

Special emphasis was placed on integrating findings from Uzbek researchers with international evidence to ensure a comprehensive and regionally relevant interpretation of the results.

Results and Discussion

Biochemical parameters and mineral metabolism. The analysis of the reviewed literature demonstrates that biochemical alterations in saliva and blood play a fundamental role in the pathogenesis of sialolithiasis. Increased concentrations of calcium and phosphate ions lead to supersaturation of saliva, which facilitates nucleation and subsequent crystal growth.

In addition, local studies by Jumayev L.R. have confirmed significant changes in biochemical parameters among patients with salivary gland disorders, particularly in calcium metabolism and protein composition. These findings indicate that biochemical imbalance is not only a consequence but also a contributing factor in stone formation.

Alterations in glycoprotein composition of saliva, as reported by Jumayev and Pulatova, increase saliva viscosity and promote the formation of an organic matrix that serves as a scaffold for mineral deposition. This supports the concept that both inorganic and organic components are essential in lithogenesis.

Immunological and inflammatory mechanisms

Immunological changes are closely associated with the inflammatory processes observed in sialolithiasis. Elevated levels of pro-inflammatory cytokines, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), have been reported to contribute to tissue damage and ductal obstruction.

Regional studies also indicate that patients with reactive-dystrophic salivary gland diseases exhibit significant alterations in immune system parameters, suggesting an active role of immune dysregulation in disease progression.

Chronic inflammation leads to epithelial desquamation, increased mucus production, and narrowing of salivary ducts, all of which contribute to saliva stagnation and further mineral precipitation. These findings highlight the interdependence between inflammation and obstruction in the pathogenesis of sialolithiasis.

Microbiological factors and biofilm formation

The role of microbial agents in salivary stone formation has gained increasing attention in recent years. Bacterial biofilms have been identified as potential nucleation centers for mineral deposition.

Studies indicate that microorganisms contribute to the formation of an organic core within salivary stones, around which mineral layers accumulate. Local microbiological investigations also confirm the presence of altered oral microflora in patients with salivary gland diseases.

This suggests that microbiological analysis may serve not only as a diagnostic tool but also as a prognostic indicator of disease progression and recurrence.

Changes in salivary composition and physicochemical properties

Saliva plays a central role in maintaining oral homeostasis, and its physicochemical properties are critical in the development of sialolithiasis [11].

The reviewed studies demonstrate that: decreased salivary flow rate, increased viscosity, reduced pH create favorable conditions for crystallization and stone formation.

These changes are often associated with dehydration, metabolic disorders, and functional impairment of salivary glands. According to both local and international data, saliva stagnation is a key initiating factor in lithogenesis [12],

[13].

Diagnostic significance of laboratory parameters

The integration of laboratory findings with clinical and imaging data significantly enhances diagnostic accuracy. Laboratory indicators provide early information about pathological changes that may not yet be visible through instrumental methods.

Biochemical markers reflect mineral imbalance, immunological indicators reveal inflammatory activity, and microbiological findings indicate infectious involvement.

Importantly, several studies emphasize that laboratory parameters can be used not only for diagnosis but also for monitoring treatment effectiveness and predicting recurrence.

Comparative analysis and clinical implications

Comparative evaluation of local and international studies reveals a high level of consistency in identifying key pathogenic mechanisms of sialolithiasis [14].

However, regional studies provide additional insights into population-specific factors, including environmental influences, dietary habits, and water mineral composition, which may significantly affect salivary stone formation.

Despite these advances, a major limitation remains the absence of standardized laboratory diagnostic criteria [15]. This highlights the need for further research aimed at identifying reliable biomarkers and developing unified diagnostic algorithms.

Synthesis of findings. Overall, the results of this review indicate that sialolithiasis is a multifactorial disease involving complex interactions between biochemical, immunological, microbiological, and physicochemical factors.

Conclusions

The findings of this comprehensive review demonstrate that sialolithiasis is a multifactorial disease involving complex interactions between biochemical, immunological, microbiological, and physicochemical processes.

Laboratory diagnostics plays a crucial role in elucidating the underlying mechanisms of salivary stone formation and provides valuable complementary information to clinical and imaging findings. In particular, alterations in calcium metabolism, inflammatory mediators, and salivary composition have been identified as key factors associated with disease development and progression.

The analysis confirms that laboratory parameters can serve not only as diagnostic indicators but also as tools for early detection, disease monitoring, and evaluation of treatment effectiveness. Integration of laboratory findings into routine diagnostic protocols significantly enhances the accuracy and timeliness of diagnosis.

At the same time, the lack of standardized laboratory biomarkers and unified diagnostic criteria remains a major limitation in current clinical practice. Therefore, further research is required to identify reliable molecular and biochemical markers and to develop evidence-based diagnostic algorithms. In conclusion, a multidisciplinary approach combining laboratory, clinical, and instrumental methods represents the most effective strategy for improving the diagnosis, management, and prevention of sialolithiasis.

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