

Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)

ISSN 2760-4942 (Online) Volume 2, Issue 2, February 2026



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PREDICTION OF THE DEVELOPMENT, CLINICAL COURSE, AND OUTCOME OF SALIVARY STONE DISEASE

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Abstract

Salivary stone disease (SSD), also known as sialolithiasis, represents one of the most prevalent pathologies of the salivary glands, accounting for up to half of all disorders affecting this anatomical region. Despite the availability of diagnostic criteria and characteristic clinical manifestations, the rate of diagnostic errors remains unacceptably high, often resulting in delayed or inadequate treatment and an increased risk of chronic inflammation and complications. Current therapeutic strategies are predominantly focused on surgical management and resolution of acute inflammatory episodes, while insufficient attention is paid to early diagnosis, prognostic assessment, and prevention of recurrence.

The present study aimed to identify unresolved issues and define prospective research directions in predicting the development, clinical progression, and outcomes of salivary stone disease. The analysis revealed the absence of a rational experimental model of SSD, as well as the lack of a scientifically validated system of prognostic tests suitable for both inpatient and outpatient settings.

Keywords: Salivary glands, salivary stone disease, prognosis, microcrystallization, oral fluid, sialolithiasis.



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Introduction

Salivary stone disease is among the most frequently encountered disorders of the salivary glands. According to data reported by both domestic and international authors, SSD constitutes approximately 50% of all salivary gland pathologies, with regional prevalence reaching 52–80% in certain populations. Although numerous studies have addressed the diagnostic aspects of SSD and its characteristic clinical presentation, a substantial number of diagnostic inaccuracies persist.

These shortcomings contribute to the selection of suboptimal treatment strategies and inadequate medical rehabilitation, frequently leading to chronic inflammation and an increased incidence of complications. In most clinical settings, SSD management is limited to surgical intervention and suppression of acute inflammatory processes within the affected gland, whereas the issues of early diagnosis, prognostic evaluation, and prevention of recurrent stone formation remain insufficiently explored.

In recent years, clinical crystallography has emerged as a promising interdisciplinary field focused on the analysis of crystalline structures in human biological fluids. This approach provides valuable information regarding organ function, systemic homeostasis, and pathological alterations. Pathological processes induce qualitative and quantitative changes in crystal morphology, which may serve as potential diagnostic and prognostic markers.

Particular attention has been directed toward the study of oral fluid, which can be collected non-invasively, repeatedly, and in sufficient volumes. These characteristics make oral fluid an attractive medium for the development of prognostic tools in salivary gland diseases.

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Materials and Methods

An extensive review of domestic and international scientific literature was conducted to analyze existing experimental models of salivary stone disease, clinical diagnostic approaches, and methods for predicting disease development, progression, and outcomes. The review included peer-reviewed journals published over the past 15 years, as well as fundamental textbooks and monographs without temporal restrictions.

A descriptive analytical method was employed to identify unresolved scientific problems and to outline promising directions for further research.

Results and Discussion

One of the principal factors contributing to adverse outcomes in salivary stone disease is diagnostic error, largely conditional the absence of accessible, reproducible, and objective prognostic methods capable of predicting disease onset, progression, and outcome.

Salivary stones (sialoliths) are calcified formations that develop within salivary ducts or glandular parenchyma. The clinical course of SSD is traditionally divided into three clinico-morphological stages: an initial stage, a clinically manifest stage, and a late stage. The initial stage is typically characterized by minimal or absent symptoms, salivary stasis, and mild glandular enlargement. Patients may experience slight discomfort during meals or salivary stimulation, which often leads to underdiagnosis or misdiagnosis.

Differential diagnosis is further complicated by the overlap of early SSD symptoms with those of other salivary gland disorders. Comprehensive diagnostic evaluation includes standard clinical methods (history taking, inspection, palpation) and specialized imaging techniques. Currently used imaging modalities include conventional radiography, ultrasonography, contrast sialography, scintigraphy, computed tomography, and magnetic resonance imaging.

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However, numerous authors emphasize the limitations of radiological methods, including their inability to accurately reflect dynamic pathological changes over short observation periods and a considerable diagnostic error rate ranging from 7% to 46%. Additionally, 15–40% of salivary stones are radiolucent and therefore undetectable using standard imaging techniques. Radiological approaches also fail to reliably identify non-mineralized sialoliths, stones smaller than 2 mm, soft-tissue pathology, or subtle ductal changes without the use of contrast agents, which carry a risk of allergic reactions.

The etiology of sialolith formation remains incompletely understood and continues to be a subject of debate. It is widely accepted that both qualitative and quantitative alterations in salivary composition play a critical role, alongside factors such as ductal trauma, salt precipitation, and changes in the physicochemical properties of oral fluid.

Several pathogenetic theories have been proposed. The retrograde infection theory suggests that food debris, microorganisms, or foreign substances may migrate into salivary ducts and serve as a nidus for subsequent calcification. Systemic factors, including disturbances of mineral metabolism and vitamin A deficiency, have also been implicated. Salivary stone disease frequently develops in patients with systemic conditions affecting calcium-phosphate metabolism, which is supported by the common coexistence of salivary, renal, and biliary calculi.

The concept of primary multiple biolithiasis has been introduced to describe the systemic propensity for stone formation in various organs. Analogies have been drawn between the mechanisms of sialolithiasis and urolithiasis, particularly the proteolysis-ion theory, which postulates that stone formation requires both an optimal pH for salt sedimentation and insufficient proteolytic activity, resulting in gel matrix formation and subsequent mineral deposition.

Experimental data indicate that microcalculi are frequently present in salivary gland acinar cells and may act as precursors to clinically significant stones,

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particularly under conditions of impaired salivary outflow. The relative rarity of sialolithiasis in the parotid gland has been attributed to the presence of statherin, a potent inhibitor of calcium phosphate precipitation.

Dietary habits and drinking water composition also influence salivary electrolyte balance and pH. Deviations from physiological pH values reduce the stability of colloidal micelles in saliva, thereby promoting mineral precipitation.

Despite the multitude of proposed mechanisms, most researchers agree that sialolithiasis is a multifactorial condition, with no single dominant etiological factor universally accepted. Importantly, there is a notable lack of evidence-based studies systematically analyzing clinical and laboratory parameters of oral fluid with respect to their diagnostic and prognostic value in SSD.

Existing publications addressing prognosis in salivary stone disease are sparse and predominantly descriptive in nature. Attempts have been made to correlate clinical and morphological features of SSD with somatotype, as well as to employ three-dimensional reconstruction techniques to assess stone morphology and optimize surgical planning. Nevertheless, these approaches remain limited in scope and applicability.

To date, no adequate experimental model of salivary stone disease has been described that would allow comprehensive investigation of its pathogenesis, including morphological and biochemical aspects. The absence of such a model significantly hampers the identification of reliable prognostic markers and the development of effective preventive strategies.

Conclusion

The analysis of contemporary scientific literature demonstrates a critical lack of:

- a rational and reproducible experimental model of salivary stone disease;
- validated physical, biochemical, and immunological parameters of oral fluid suitable for prognostic assessment;

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• a scientifically substantiated system of prognostic tests applicable in both inpatient and outpatient clinical practice.

These gaps underscore the urgent need for further interdisciplinary research aimed at developing evidence-based prognostic tools to predict the development, clinical course, and outcomes of salivary stone disease.

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