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HISTOMORPHOLOGICAL CHARACTERISTICS OF MAXILLARY SINUS CYSTS

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Abstract:
Cysts of the maxillary sinus (sinus maxillaris) represent one of the most common pathological conditions encountered in maxillofacial surgery and otorhinolaryngological practice. Their aetiology, clinical course, and potential complications are influenced by a variety of factors. This scientific article provides an in-depth analysis of the histomorphological characteristics of maxillary sinus cysts, with particular emphasis on the types of epithelial lining, the structural organisation of the connective tissue stroma, inflammatory cell infiltration, vascular alterations, and degenerative processes. Based on the results of histological and histomorphometric examinations, the pathogenetic mechanisms of cyst formation are substantiated, along with their clinical significance and the decisive role of histological assessment in accurate diagnosis.

Keywords: Maxillary sinus, maxillary sinus cysts, histomorphology, epithelial lining, connective tissue, inflammatory infiltration, degenerative changes.

Introduction

Maxillary sinus cysts occupy a significant position among cystic lesions encountered in the maxillofacial region and remain a frequent finding in both dental and otorhinolaryngological clinical practice. These lesions are commonly associated with odontogenic inflammatory foci, chronic rhinosinusitis, maxillofacial trauma, and functional disturbances of the secretory activity of the sinus mucosal glands. In many cases, cyst formation represents a multifactorial pathological process in which local inflammatory stimuli interact with anatomical and physiological characteristics of the maxillary sinus mucosa [1].

Epidemiological studies indicate that cysts of the sinus maxillaris are widely prevalent in the adult population, with reported detection rates

increasing due to the routine use of cone-beam computed tomography and other advanced imaging modalities. Notably, a substantial proportion of these cysts remain asymptomatic for prolonged periods and are often identified incidentally during radiological examinations conducted for unrelated dental or ENT conditions [2]. Despite their frequently silent clinical course, maxillary sinus cysts may progressively enlarge and cause sinus obstruction, facial pain, nasal congestion, dental symptoms, or secondary infectious complications when left undiagnosed or untreated.

The clinical significance of maxillary sinus cysts is determined not only by their size and anatomical localisation but also by the histomorphological architecture of the cyst wall. In particular, the type of epithelial lining, the degree of inflammatory cell infiltration within the connective tissue stroma, the extent of fibrotic transformation, and the presence of vascular and degenerative changes are considered critical factors influencing cyst growth dynamics, recurrence risk, and the likelihood of complications [3]. Variations in epithelial differentiation—ranging from pseudostratified ciliated respiratory epithelium to squamous metaplasia—may reflect chronic inflammatory stimulation and adaptive responses of the sinus mucosa.

Histomorphological and histomorphometric analyses provide essential insights into the pathogenetic mechanisms underlying cyst development and progression. Chronic inflammation plays a pivotal role in inducing structural remodelling of the sinus mucosa, including stromal fibrosis, glandular hyperplasia, microvascular alterations, and degenerative changes within the epithelial and connective tissue components [4]. These microscopic features not only clarify the biological behaviour of the cysts but also assist in differentiating between retention cysts, radicular cysts extending into the sinus cavity, and other cystic or tumour-like lesions of the maxillary sinus.

Given the diagnostic limitations of imaging techniques in determining the biological nature of cystic lesions, histological examination remains the gold standard for definitive diagnosis and therapeutic decision-making. A comprehensive understanding of the histomorphological characteristics of maxillary sinus cysts is therefore essential for optimising clinical management strategies, selecting appropriate surgical or conservative

treatment approaches, and predicting clinical outcomes [5]. Consequently, the detailed study of these features continues to be a matter of considerable relevance in contemporary dentistry and otorhinolaryngology.

Materials and methods

Classification of Maxillary Sinus Cysts. From a morphological perspective, maxillary sinus cysts are subdivided into several principal groups, including retention cysts, pseudocysts, cysts of odontogenic origin, and cystic lesions developing on the background of chronic inflammation. This classification is closely related to differences in histological architecture, particularly in terms of epithelial lining, stromal organisation, and inflammatory activity. Each cyst type demonstrates distinct morphological features that reflect its underlying aetiology and biological behaviour, thereby influencing diagnostic interpretation and therapeutic decision-making.

Histomorphological Features of the Epithelial Lining. Histological examination reveals that the inner surface of maxillary sinus cysts is most commonly lined by pseudostratified ciliated columnar epithelium characteristic of the respiratory mucosa. In a proportion of cases, the epithelial lining undergoes metaplastic transformation into stratified squamous epithelium, which is considered a morphological marker of long-standing or recurrent chronic inflammatory stimulation.

At the cellular level, epithelial alterations include vacuolar degeneration of the cytoplasm, nuclear pyknosis, and increased mitotic activity, indicating both degenerative and proliferative processes. In cysts associated with pronounced inflammatory activity, the epithelial layer demonstrates irregular thickening, focal desquamation, and areas of superficial erosion. A reduction or complete loss of ciliated cells is frequently observed, reflecting impaired mucociliary clearance and functional compromise of the sinus mucosa.

Condition of the Connective Tissue Stroma. The outer layer of the cyst wall is composed predominantly of dense fibrous connective tissue characterised by irregularly arranged collagen fibres. An increased number

of fibroblasts and fibrocytes within the stroma indicates active fibrotic remodelling. Vascular structures are often dilated, with thickened vessel walls; in certain cases, features of vascular stasis and microthrombosis are evident, suggesting chronic circulatory disturbances within the cyst wall.
Against a background of persistent inflammation, the stromal tissue exhibits inflammatory cell infiltration consisting primarily of lymphocytes, plasma cells, macrophages, and, to a lesser extent, neutrophils. The density and distribution of this inflammatory infiltrate serve as important indicators of the severity and chronicity of the pathological process and are closely correlated with the clinical course of the disease.

Inflammatory Processes and Immunomorphological Changes. Inflammation within maxillary sinus cysts is predominantly secondary in nature and induces a spectrum of morphological changes affecting both epithelial and stromal components. Histological sections commonly demonstrate tissue oedema, accumulation of interstitial fluid, and increased vascular permeability. In selected cases, elements of granulomatous inflammation, including multinucleated giant cells, may be identified, reflecting an intensified or atypical immune response.
These immunomorphological alterations contribute to progressive tissue remodelling and may facilitate cyst expansion, recurrent inflammation, or secondary infection, thereby increasing the clinical complexity of the lesion.

Degenerative and Dystrophic Changes. In long-standing cystic lesions, the epithelial lining frequently exhibits atrophic changes accompanied by mucoid and hyaline degeneration. Within the connective tissue stroma, progressive fibrosis and sclerosis are commonly observed. The cystic cavity may contain serous, mucous, or purulent exudate, depending on the degree of inflammatory activity and secondary microbial contamination. Such degenerative and dystrophic changes significantly increase the risk of cyst infection and the development of local complications.

Clinical Significance of Histomorphological Changes. The identified histomorphological features represent critical diagnostic criteria for

assessing the clinical behaviour of maxillary sinus cysts. Cysts characterised by epithelial metaplasia, marked fibrosis, and intense inflammatory infiltration are generally less responsive to conservative treatment approaches and demonstrate a higher likelihood of requiring surgical intervention. Consequently, comprehensive histomorphological evaluation plays a decisive role in treatment planning, prognosis determination, and the prevention of disease recurrence.

Conclusion

The histomorphological characteristics of maxillary sinus cysts play a crucial role in elucidating their origin, stages of development, and patterns of clinical progression. The type of epithelial lining, together with the extent of inflammatory infiltration and fibrotic transformation within the stromal component, constitutes a decisive determinant of cyst growth dynamics and the risk of complication development. Progressive epithelial metaplasia, pronounced stromal fibrosis, and persistent inflammatory activity are indicative of chronicity and are frequently associated with a less favourable response to conservative treatment strategies.

A diagnostic approach based on detailed histological evaluation enables accurate differentiation between various cystic lesions of the maxillary sinus and provides essential information for predicting biological behaviour. Integration of histomorphological findings into clinical decision-making facilitates precise diagnosis, rational selection of therapeutic modalities, and optimisation of treatment outcomes. Consequently, histological examination remains an indispensable component in the comprehensive management of maxillary sinus cysts and contributes significantly to improving patient prognosis and reducing recurrence rates.

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