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REVIEW ARTICLE

SIALOLITHIASIS: REVIEW

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Abstract

Objectives. Sialolithiasis is the most common obstructive salivary gland disease, responsible for approximately 50% of salivary glands pathology cases.

The aim of this study is to provide the literature review to present the incident rate, etiology, diagnostic and treatment trends of sialolithiasis

Materials and methods: Data from the Medline database, PubMed.gov and supplementary sources were used to conduct a systematic literature search.

Results: The 116 studies were analyzed. The relevant data were exported, summarized and presented.

Conclusion: The most of available studies regarding the incidence rate of sialolithiasis have been based on selected hospital data and there are a few multicenter analyses. The etiology of salivary stones formation remains not completely clear and various hypotheses have been put forward, thus research into etiologic factors is still continues. Despite the introduction of new technologies in the diagnostics of salivary gland, the routine methods like radiographs and ultrasound examination are still relevant and widely used. Gland preserving techniques in the treatment of sialolithiasis have continuously replaced radical surgery.

Keywords: Sialolithiasis; Salivary glands; Submandibular gland; Parotid gland; Sialendoscopy

Introduction

Sialolithiasis is the most common obstructive salivary gland disease, responsible for approximately 50% of salivary glands pathology cases.[1-8]. Sialolithiasis involves formation of calculi in the ductal systems of the salivary glands and primarily affects the submandibular glands (80% to 90% of cases).[1-9] Sialolithiasis is characterized by the development of calcified structures in the salivary glands, especially in the submandibular gland. Sialoliths are generally attributed to retention of saliva and are usually accompanied by swelling and pain when a salivary stimulus is applied.[1,10] Salivary stones consist of an amorphous mineralised nucleus, surrounded by concentric laminated layers of organic and inorganic substances. The organic components of salivary stones include collagen, glycoproteins, amino acids and carbohydrates. The major inorganic components are hydroxyapatite, carbonate apatite, whitlockite and brushite.[11,12]

Patients with sialolithiasis frequently present with swelling and pain after eating and a history of recurrent acute suppurative sialadenitis.[1,2,6,7]

Nowadays, epidemiologic features and clinical manifestations of sialolithiasis play an important role, assisting not only in diagnosis but also in determining appropriate treatment.[13,14]

The aim of this study is to provide the literature review to present the incident rate, etiology, diagnostic and treatment trends of sialolithiasis.

Material and Methods

Data from the Medline database, PubMed.gov and supplementary sources were used to conduct a systematic literature search.

Results

The 116 studies were analyzed. The relevant data were exported, summarized and presented.

Etiology

The etiology of salivary stones formation remains not completely clear, and research into etiologic factors is still limited, thus various hypotheses have been put forward. These hypotheses include the agglomeration of sialomicroliths, anatomical variations of the salivary ducts and an altered biochemical composition of saliva.[4,6,11-14]

Sialomicroliths, which are calcium and phosphorus crystal concretions, have been identified in serous acinar cells, striated ductal cells, lumen and interstitium of almost all normal submandibular glands and in 10–20% of the normal parotid glands.[9,11,15] Factors that are believed to affect salivary stones formation are divided into two major groups: anatomical, affecting saliva formation or flow (i.e., duct stenosis, duct's length and its antigravitational flow or inflammation), and compositional (i.e., increased calcium content or altered enzyme function).[8,10,14,]

Studies have shown that sialolithiasis is more frequently located in major salivary glands, particularly in the submandibular and parotid glands.[15] Sigismund PE and coauthors (2015) observed a total of 2,959 calculi by ultrasound examination.[13] Of those, 80.4% were located in the submandibular duct system (53% hilar/proximal, 37% distal, 10% intraparenchymal) and 19.6% were parotid stones (83% in Stensen's duct, 17% intraparenchymal). This is likely due to the long and tortuous path of the major duct as well as the nature and consistency of the submandibular gland saliva, which is thicker in consistency, rich in phosphorous, and has a high pH that is conducive to sialolith formation.[9] Mimura M. with coauthors (2005) have performed biophysical analysis of calculies from 13 patients to understand some possible etiologies of calculi formation. Analysis of the area including mitochondria-like structures, lysosomes, and the fibrous structures by electron diffraction revealed the presence of hydroxyapatite and calcified materials, which could proposed that mitochondria and lysosomal bodies from the ductal system of the submandibular gland could be the etiological source for calcification in the salivary gland.[9] Kraaij, S., and coauthors (2023) identified α-amylase (in all stones; 100%), lysozyme (95%), lactoferrin (85%), secretory-IgA (75%), MUC7 (60%), complement C4 (60%) and C-reactive protein (35%). In their study authors suggests, that interaction of lactoferrin with s-IgA could contribute to the accumulation of lactoferrin in sialoliths.[12]

Busso, C.S., Guidry, J.J. with coauthors (2020) provide the results of the analysis which revealed that two important possibilities exist in the formation of sialoliths: the exosomal APR content (evidence of immune activation) and the presence of lymphocytic structures, and the mechanistic similarities between the formation of salivary and kidney stones, and the potential relationship with hyperoxaluria.[17]The authors have suggested an interesting theory which supports a hypothesis that all pathological bodily concretions like glandular stromal stones (salivary, thyroid, lung, heart, pineal etc.) may share a general common formational pathway. Elucidating such a mechanism could potentially influence research methodology, device and technology development, and clinical management of lithiasis in general.[17] The similar assumption was proposed by Kim do H. with coauthors (2013) that patients with sialolithiasis are more prone to develop nephrolithiasis, and sialolithiasis has been linked with nephrolithiasis in up to 10% of patients.[18]

Research examining the geographic distribution of hard water and salivary calculi formation demonstrated no correlation with an increased incidence of salivary stones in areas of increased water hardness.[19] Studies examining the effects of hypercalcemia using animal models demonstrated no evidence of increased salivary stones with hypercalcemia.[20] Additional factors such as decreased fluid intake and pharmacologic side effects resulting in decreased salivary production (i.e., diuretic use) remain under study. In recent years tobacco smoking has been discussed as a potential risk factor for the formation of salivary stones. Tobacco may induce inflammation within the salivary ducts and decrease the production of salivary amylase.[21]

Park, J. with coauthors (2024) have compared the microbial composition of saliva and salivary stones from individuals with and without salivary stones and found that bacterial communities were similar in the saliva of patients and healthy individuals. Their findings discover a relationship between the oral microbiome and salivary stone formation, which suggests that it is possible to inhibit or alter the growth of salivary stones in the salivary duct by modulating the microbial community present in the saliva, and suggests the possibility of applying this strategy in the future to develop novel treatments for sialolithiasis.[22]

There is practically no literature on possible familial risk or genetic predisposition in sialolithiasis.[23,24]

Epidemiology

According to reports from 2015, in the US alone, the epidemiological incidence of sialolithiasis has an incidence of 450 cases per 100,000 individuals/year (mostly treated surgically).[17] The most of available studies regarding the incidence rate of sialolithiasis have been based on selected hospital data and there are a few multicenter analyses.[4,5,7,8,13,16,18,25]

Schrøder SA with coauthors (2017) conducted a population-based study evaluating the incident rate of sialolithiasis and their variation according to age, gender and geography in Denmark. The incident rate was 7.27 and 14.10 per 100,000 person-years based on visually confirmed cases only and on all cases, respectively. The highest IR was observed among 60- to 70-year-olds, in the North Denmark region and among females.[25]

In their 12-year retrospective study in Iraq, Aldelaimi AA et al. (2022) concluded that salivary gland obstructive lesions were the most common salivary gland abnormalities and accounted for 52.2% of SGPs. Sialolithiasis tends to peak in incidence between the ages of 30 and 70 with no sex predilection.[7]

Mohan et al. (2011), in their 15-year retrospective study, noted that nonneoplastic salivary gland diseases are more common than neoplastic diseases and have a wide disease spectrum. Among them, sialolithiasis was present in only 20.6% of salivary gland non-neoplastic disease.[26] Żurek M, Rzepakowska A et al. (2021), in their 10-year retrospective study of salivary gland patologies incidence in the Polish population, noted that 85.5% of the observed cases were nonneoplastic.[5]

Diagnostic

History and physical examination play key roles in determining the cause of a patient's sialadenitis.[12,27] The physical examination should include bimanual palpation of the floor of the mouth in a posterior to anterior direction for submandibular glands or an intraoral palpation around Stensen's duct for parotid glands.[12] The calculus may be palpable upon physical examination, and massage of the affected gland may produce a decreased amount of saliva that is cloudier than normal.[27] Complications of sialolithiasis include acute suppurative sialadenitis, stricture, and ductal ectasia.[11,27,28] Demonstration of sialoliths by radiographic examination is effective in approximately 80% of the cases.[12] Although calculi affecting the parotid and submandibular glands are similar in chemical composition, 90% of submandibular calculi are radiopaque whereas a similar percentage of parotid calculi are radiolucent when imaged with standard facial x-ray scans.[29] Upon radiographic examinations an occlusal radiograph is the most useful method for detection of a submandibular sialolith.[12] While conventional radiography can still be useful in the initial workup of salivary stones, modern imaging techniques using ultrasound or CT scans can accurately diagnose the sialoliths and provide their exact location.[8,20]

A number of inflammatory and reactive lesions of the salivary glands may mimic neoplastic disease, so in most patients, imaging diagnosis, including ultrasonography and magnetic resonance imaging or computed tomography, must be routinely performed.[5] Ultrasonography is a gold standard for salivary glands examination and provides a non-invasive method of imaging sialolithiasis. The usual appearance of sialoliths on ultrasound is a hyperechoic focus with posterior shadowing.[8] Non-contrast computed tomography is a widely used modality for the evaluation of sialolithiasis. It is a valid tool for diagnosing sialolithiasis when it is big enough or when the radiographic slices are done every millimeter.[8,20] Disadvantages include radiation exposure and limited evaluation of the ductal system or underlying pathology (ie, obstructing masses).[20]

Magnetic resonance imaging (MRI) is able not only to visualize larger stones but able in many instances to map the ductal anatomy and to assess the gland. Stones appear as low signal regions (on all sequences) outlined by high signal saliva on T2 weighted images. MRI is able to distinguish acute from chronic obstruction as well as glands with only incomplete obstruction.[30] MR sialography is an increasingly popular diagnostic technique in which the patient's own salivary secretion is used as a natural contrast agent and which can be conducted quickly and without any complications. It provides noninvasive accurate visualization of the ductal system of major salivary glands, especially in cases that could prove to be difficult to examine by conventional sialography.[30]

Sialendoscopy is a minimally invasive technique to visualise the salivary duct system, usually performed under general anaesthesia. An endoscope with a very small diameter (0.6 mm) is introduced into the duct after the orificium has been dilated with special instruments with increasing diameters from 0.8–1.6 mm. The endoscope has a rinse channel that can be used to flush the duct with saline or an anti-inflammatory rinse.[30,31]

Treatment

The primary objective in the treatment of sialolithiasis should be preservation of gland function in combination with a low level of complications and discomfort for the patient.[12] And in nowadays gland preserving techniques in the treatment of sialolithiasis have continuously replaced radical surgery.[14,28] Even taking into consideration the newer technologies such as salivary endoscopy, which have reduced the need for gland removal by facilitating stone fragmentation or endoscopic removal, the unpredictable nature of salivary stones in terms of hardness and invasiveness still poses difficulties for successful stone management and the traditional

surgical options may require gland removal and expose the patient to post-operative effects such as cranial nerve injury, xerostomia, and other risks associated with open surgical management.[17]
According to the treatment algorithm initial prescription of antibiotics in combination with analgesics, sialogogues and massage of the affected gland should be attempted to enable spontaneous sialolith discharge.[3,12,14,30] Sialoliths of the submandibular or parotid gland with a diameter of no more than 3 mm can usually be removed with sialendoscopy with success rates of > 90%.[14,27,28,31] Larger sialoliths within the distal third of Wharton's duct can be removed by papillotomy, whereas sialoliths within the middle third are commonly extracted by sialendoscopy.[14,32] Sialoliths within the parenchyma of the submandibular or parotid gland that cannot be removed by interventional sialendoscopy or extracorporeal shockwave lithotripsy alone may be removed by an intraoral (submandibular gland) or extraoral (parotid gland) endoscopy-assisted sialolithotomy with success rates of > 90%. [14,30, 33]

Conclusion

The most of available studies regarding the incidence rate of sialolithiasis have been based on selected hospital data and there are a few multicenter analyses. The etiology of salivary stones formation remains not completely clear and various hypotheses have been put forward, thus research into etiologic factors is still continues. Despite the introduction of new technologies in the diagnostics of salivary gland, the routine methods like radiographs and ultrasound examination are still relevant and widely used. Gland preserving techniques in the treatment of sialolithiasis have continuously replaced radical surgery.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not Applicable.

Availability of data and materials

Not Applicable.

Competing interests

No conflict of interest.

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