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Case Report

Diagnostic Value of Cone Beam Computed Tomographic (CBCT) Scan in Detection of a Stensen's Duct Lithiasis Presenting as a Longstanding Case of Recurrent Buccal Space Abscess

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Abstract

Current diagnostic tools used in the imaging of Sialoliths of the major salivary glands and their ducts include conventional radiography, ultrasonography, computed tomography, sialography, magnetic resonance sialography and sialoendoscopy. Their identification on radiographs is often constrained by their degree of calcification. Many poorly or partially calcified sialoliths are not detected by conventional radiography until they are more than 60 to 70% calcified, with at least 20% of submandibular and 50% of parotid stones missed on intraoral and panoramic radiography, which they are not sensitive enough to detect them. High-resolution Non-Contrast Computed Tomographic (NCCT) scanning is useful for the detection and evaluation of salivary stones, however this facility is not routinely accessible, requires elaborate, space occupying equipment and an expensive and time taking procedure, which is associated with attendant risks of high radiation exposure. Sialoliths which are not detectable even on CT may require more invasive procedures such as sialoendoscopy or sialography.

We propose an even better option as the imaging modality of choice, the Cone beam Computed Tomographic (CBCT) scan, which is 10 times more sensitive than conventional CT and which also limits the radiation exposure to merely that of an Intraoral Periapical (IOPA) radiograph or less than one fourth that of a conventional panoramic radiograph such as the Orthopantomogram (OPG).

Its sensitivity and specificity in detecting and correctly identifying small soft tissue accretions and calcifications and providing a precise three dimensional localization of even tiny sialoliths in relation to the nearby anatomic structures, without being superimposed by bones of the maxillofacial skeleton and with negligible metal or motion artifact formation, makes CBCT superior to intra- or extraoral radiographs, panoramic radiographs or CT scans, and hence may be considered as the 'Gold Standard' or imaging modality of choice of ductal or glandular sialoliths.

Keywords: Cone-beam Computed Tomographic Scan (CBCT); Multi-slice Computed Tomographic Scan (MSCT); Diagnostic Imaging; Sialolithiasis; Salivary Duct Calculi/Lithiasis

Introduction

Salivary duct lithiasis refers to the formation of concretions (sialoliths) in the excretory duct of a major or minor salivary gland, causing obstruction of salivary flow, leading to salivary ectasia or stasis, local inflammation, infection and sometimes even chronic sialadenitis of the concerned salivary gland [1]. Intraductal sialoliths have been seen to be more frequent than intraglandular/parenchymal sialoliths. Ductal lithiasis are more often located within the ductal system of the submandibular gland (comprising 72% - 95% of all ductal calculi) [2] rather than of the parotid gland (4% - 28%). Depending upon size and site of the sialolith, diagnostic as well as treatment options vary.

The diagnoses of sialoliths of the major salivary glands or their ducts are often delayed because of their rather non-specific symptoms and due to failure of routine imaging modalities, such as radiographs, to detect them until they reach an advanced degree/stage of calcification, which only then make them radiopaque enough to be identifiable [3]. Moreover, imaging of the maxillofacial region is limited with conventional radiography due to the overlap and superimposition of various anatomical structures such as bones of the maxillofacial skeleton, making visualization of the area of interest very difficult.

Conventional intra- and extra-oral radiography is more useful in detecting submandibular sialoliths as compared to those of the parotid gland or Stensen's duct, due to course of the latter around the anterior portion of the masseter muscle and through the buccinator, areas which are superimposed by the images of bones of the mid-third of the face [1]. In general, only the sialoliths located in the anterior part of the duct, in front of the masseter muscle, can be visualized by means of intra-oral radiography, and that too only if they are 60 - 70% calcified. Also, intraoral and extraoral imaging procedures, used individually or in combination, suffer from the same inherent limitations of all planar two-dimensional (2D) projections, namely, magnification, distortion, superimposition, and misrepresentation of structures [4]. 50% per cent of parotid and 20% of submandibular stones are not radiopaque and hence more invasive methods such as sialography may be required to locate them. Sialography, however, is contraindicated in the presence of acute infection or inflammation due to the risk of exacerbating or disseminating the infection [5].

Conventional CT scans used to be the mainstay in the diagnosis of sialolithiasis, but its use is limited by factors such as cost, access and radiation dose considerations [6]. Cone-beam computed tomography (CBCT) is an advanced dental and maxillofacial imaging and investigative modality that has found numerous clinical applications in all fields of dentistry and maxillofacial surgery [7].

CBCT scanning has been found to afford a number of advantages over conventional Multi-slice Computed Tomographic (MSCT) scanning, in that it is easily affordable, exposes the patient to much less radiation [8], provides an accurate and precise three dimensional localization of even tiny sialoliths in relation to the nearby anatomic structures, without being superimposed by the maxillofacial skeleton, and produces negligible motion and metal artifacts. This imaging modality is capable of providing sub-millimeter resolution (2 line pair/mm) images of higher diagnostic quality, with shorter scanning times (less than 60 seconds) [7,9]. Radiation exposure dose from CBCT is 10 to 30 times less than from conventional CT scans during maxillofacial exposure, thus greatly reducing radiation hazards for both, the clinician as well as the patient. It also has a superior dimensional accuracy (only about 2% magnification). Average radiation dose for imaging of the maxilla using conventional CT is 1031 - 1420 μSv (microsievert), whereas the effective radiation dose using the Cone beam CT is merely 36.3 μSv to 50.3 μSv (microsievert) [10]. Its relatively compact equipment can be easily installed in a dental clinic. Furthermore, CBCT imaging has a high degree of accuracy, producing images of enhanced quality and high resolution, with minimal distortion, superimposition, magnification or image degradation.

Reducing the size of the irradiated area is made possible in CBCT by collimation of the primary X-ray beam to the area of interest, thus allowing small, specific regions to be scanned, producing sharper images with excellent contrast, resolution and accuracy, in a rapid scan time, while at the same minimizing the radiation dose, scatter and suppressing the number of motion and image artifacts [11]. Since the images of CBCT are collected as a combination of several two-dimensional (2D) slices, this technique is superior in overcoming superimpositions and is helpful in calculating surface distances, helping in precise localization of even small pathologies [12]. It can provide a three-dimensional volumetric data in axial, sagittal and coronal planes.

Its sensitivity in detecting soft tissue calcifications has proved its potential in detecting these lesions in their early stage itself [13]. In addition, CBCT allows images to be acquired in a shorter patient examination time, and at lower costs than MSCT, which thus makes its routine use feasible for oral and maxillofacial procedures [14].

This report describes a persistent, longstanding case of recurrent buccal space abscess of the left side in a 38 year old male, the etiology of which had remained unidentifiable and the condition misdiagnosed and inadequately managed for over two years, until the patient reported to this hospital where an immediate Cone beam CT scan of the maxilla region correctly and expeditiously attributed the condition to a hitherto undetected sialolith of the distal part of the Stensen's duct.

Case Report

A 38 year old male patient reported with the complaint of a longstanding condition (over two years) of a recurrent painful swelling of the left cheek. Its cause had remained undiagnosed and the condition had recurred at intervals of 2 to 3 months and gradually subsided each time after antibiotic medication. The patient had also undergone intraoral incision and drainage via the buccal mucosa a year ago, however, the relief was only temporary and the swelling recurred. About nine months ago, the abscess had ruptured extraorally, leaving a sinus opening on his left cheek, which intermittently drained pus and purulent foul smelling material each time the swelling appeared.

On examination, there was a firm and painful dome shaped swelling of the of the left cheek, measuring approximately 4 cm X 3 cm, extending above upto the zygomatic arch and infraorbital rim, below upto the level of the occlusal plane, posteriorly upto the anterior border of the masseter and anteriorly upto the ala of the nose and angle of the mouth. It was accompanied by a draining sinus, which was depressed, puckered and covered by a dried crust. Palpation revealed the swelling to be firm, tense, tender and warm. The region of the sinus was indurated and a secondary purulent foul smelling discharge could be expressed from it. Submandibular lymph nodes on the left side were palpable, firm, mobile and tender.

The patient was febrile and had a restricted interincisal mouth opening which was limited to 25 cm. On intraoral examination, there were no carious, non-vital, impacted or periodontally or peri-apically involved teeth. The buccal mucosa of the involved side appeared inflamed, puffy, indurated and extremely tender opposite the upper posterior teeth. The parotid papilla too appeared swollen. There was no apparent correlation of the pain and swelling with mealtimes, hence nothing suggestive of a salivary gland involvement resulting from obstruction of flow of the food related surge of salivary secretion.

An Orthopantomogram did not reveal any abnormality or bony pathology, and there was no evidence of any carious, non-vital, impacted or periodontally or peri-apically involved tooth, thus ruling out a dental source of infection. There was no other detectable bony pathology of the maxilla or mandible. An Ultrasonogram (USG) of the region merely revealed fasciitis in the region with radiolucent locules indicative of small areas of liquefactive necrosis. The patient was then taken up for a CBCT of the region of involvement, which immediately revealed a small (0.8 cm X 0.3 cm) roughly ellipsoid radiopacity in the region just opposite the crown of the upper first molar tooth. This was suggestive of a Stensen's duct lithiasis located in the distal section of the parotid (Stensen's) duct close to its punctum. The differential diagnosis included other calcific foci such as haemangioma/phlebolith and atherosclerotic calcification, but were ruled out due to lack of specific clinical features of either.

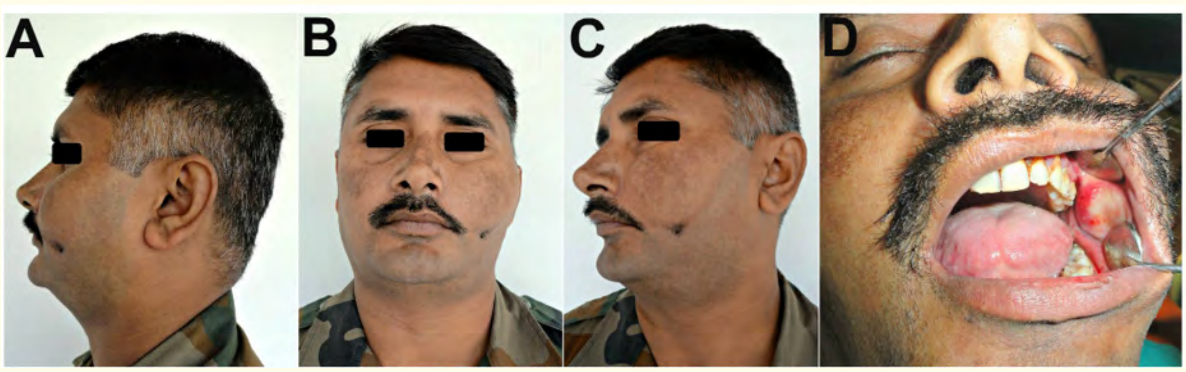

Figure 1: (A, B, C) A 38 year old male patient presented with a recurrent, large buccal space abscess on the left, accompanied by an intermittently draining sinus, which was depressed, indurated, puckered and covered by a dried crust. (D) The buccal mucosa in the region was swollen, inflamed and tender.

The sialolith was removed under local anesthesia through an intraoral approach, by making a small incision expanding the duct orifice, teasing the sialolith out gently and extricating it with the help of a mosquito artery forceps. It measured 13 mm X 5 mm, was creamy white in colour, stony hard in consistency and pebbly in texture. Purulent material was drained through the opening and the duct was thoroughly irrigated with normal saline to flush out and remove any other remaining particles or accretions if they were present. Duct patency was checked and a cannula was inserted prior to closure, so as to prevent future stricture or narrowing of the duct lumen during healing. The sinus tract leading extraorally was carefully excised and a single suture placed on the skin side. Postoperative CBCT (Figure 4) was carried out to confirm complete elimination of the sialolith.

The patient recovered uneventfully and there was a speedy and permanent resolution of the buccal swelling as well successful closure of the extraoral sinus opening, leaving an imperceptible scar in the region (Figure 4). There was no recurrence of either the swelling or the draining sinus during the entire follow up period of two years.

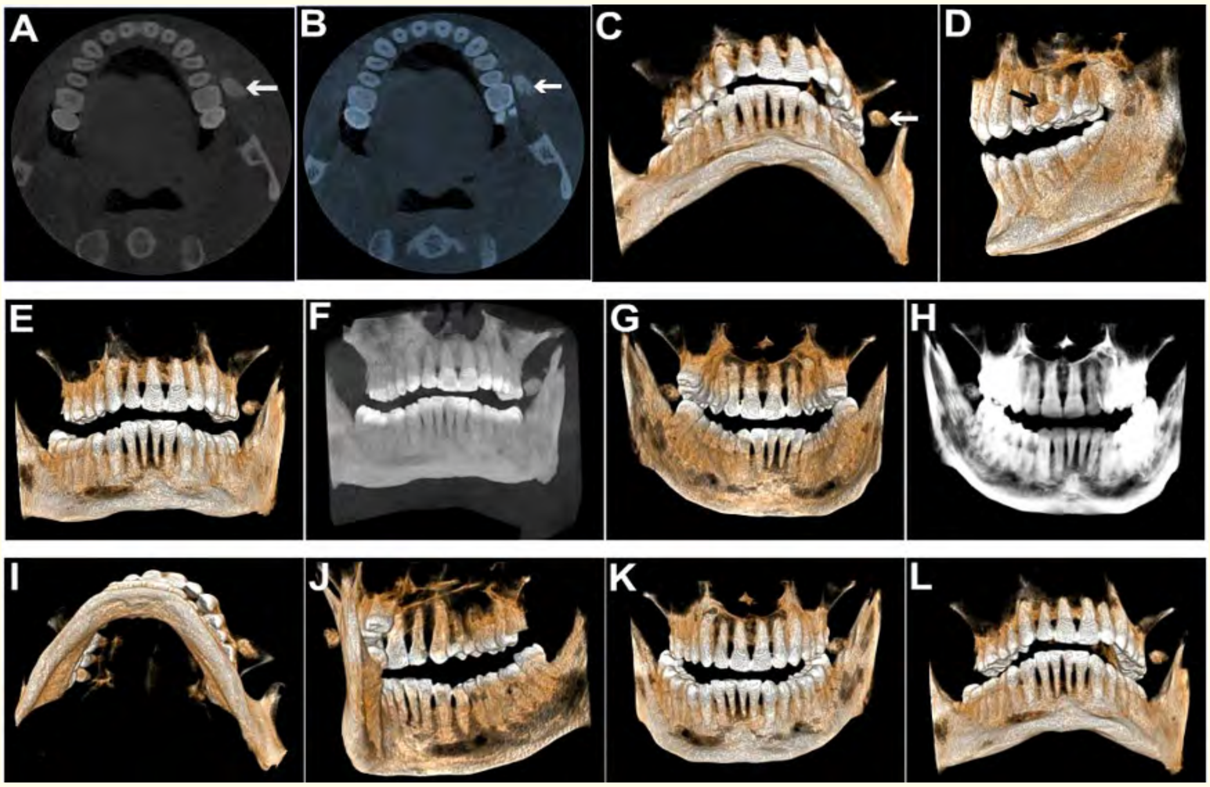

Figure 2: (A-D) Cone beam Computed Tomographic (CBCT) scan of the region revealed a roughly ellipsoid radiopacity indicating a concretion in the region of the buccal space just opposite the crown of the upper first molar tooth (as indicated by the arrows). This was suggestive of a Stensen's duct lithiasis in the distal part of the duct, close to its orifice. (E-L) In addition to 3-D reformatting, the interactive display modes produce accurate inter-relational images in all three orthogonal planes, helping in precisely locating the pathology without superimposition by adjacent bones of the maxillofacial skeleton and with nil artifacts and image distortion.

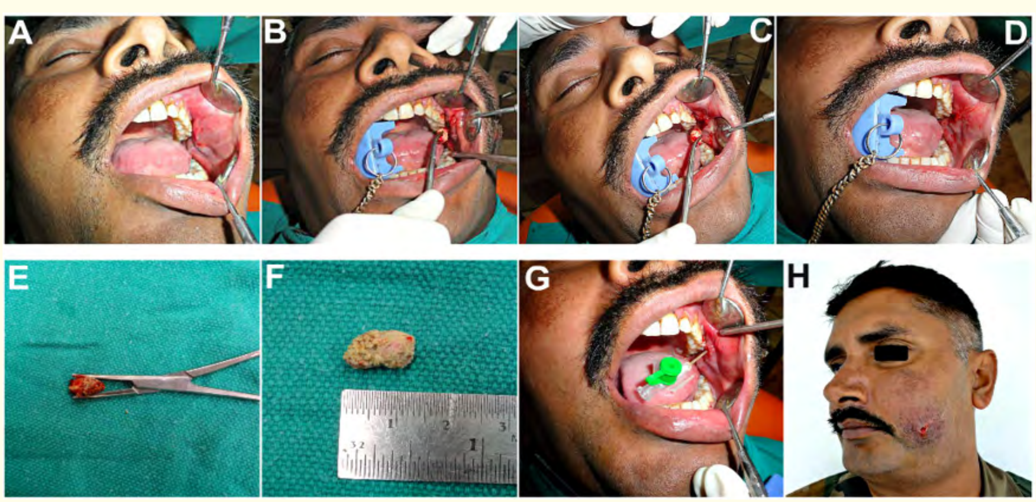

Figure 3: (A) A small intraoral incision expanding the duct orifice just opposite the crown of the upper second molar (B, C) Sialolith teased out gently and extricated with the help of a mosquito artery forceps. (D) Purulent material drained through the incision and duct thoroughly irrigated with normal saline to flush out and remove any other remaining particles. (E, F) 13 mm X 5mm Sialolith, creamy white in colour and pebbly in texture. (G) Duct patency checked and a cannula was inserted prior to closure. (H) Sinus tract leading extraorally carefully excised prior to placing a single suture on the skin side.

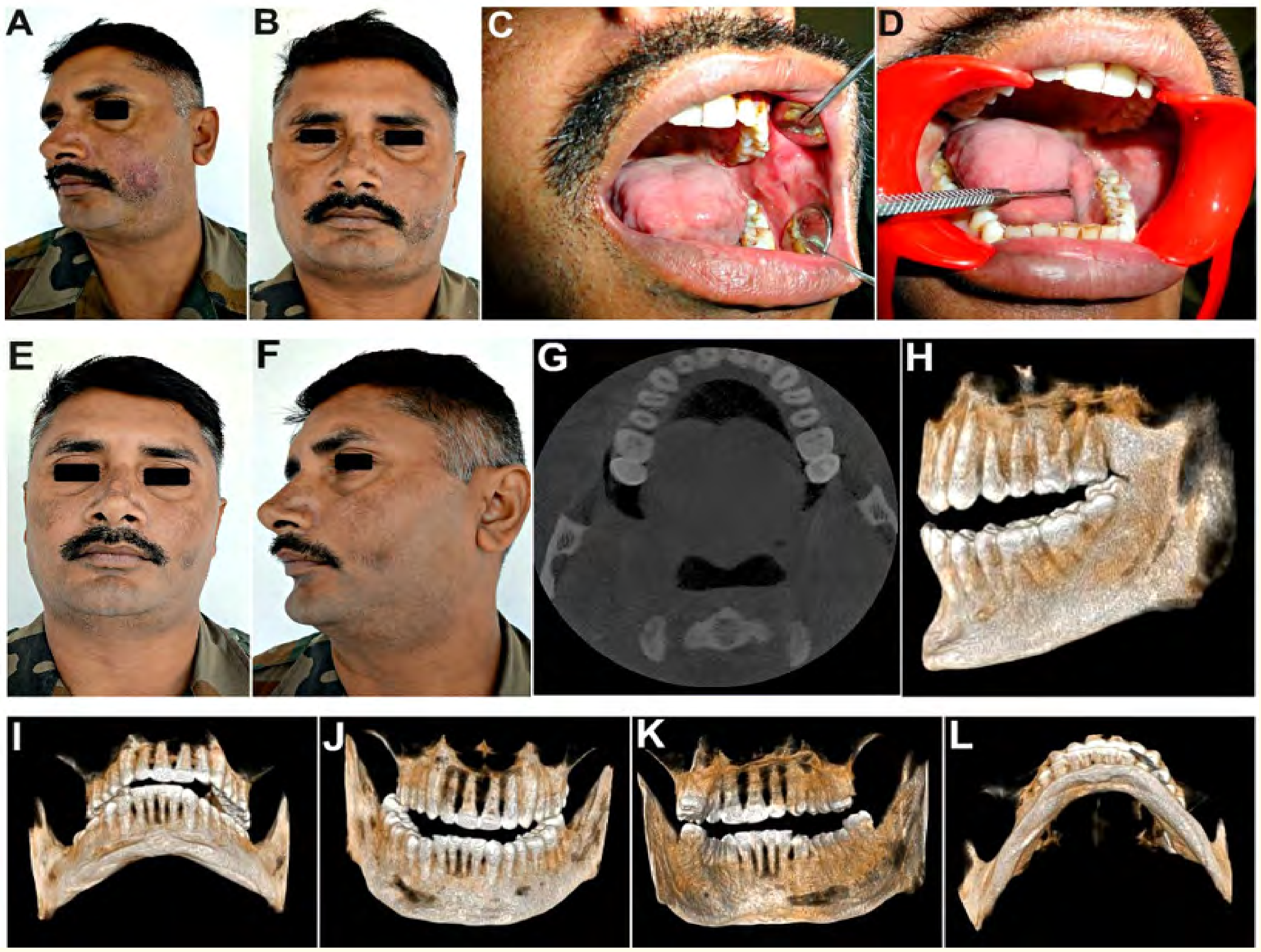

Figure 4: (A, B) One week Postoperative appearance, showing satisfactory resolution of the buccal swelling and closure of the sinus opening. (C, D) Good healing of the intraoral incision site and return of buccal mucosa to its normal colour and consistency, with a visibly patent Stensen's ductal opening through which normal saliva could be expressed. (E, F) Three weeks postoperative appearance, showing a barely perceptible scar of the completely healed extraoral sinus. (G-L) Postoperative CBCT confirming complete elimination of the Stensen's duct sialolith, with no evidence of any remaining fragments or residual concretions.

Discussion

In the case described, the patient had suffered from recurrent bouts of buccal space infection on the left side for the past two years, which was later accompanied by a chronic draining sinus on his cheek for over nine months, whilst the correct diagnosis of the cause had evaded several clinicians whom he had visited. When he reported to this hospital, the diagnosis of Stensen's duct lithiasis was not apparent on careful recording of the history and even after clinical and radiographic (Orthopantomogram) evaluation. There were no features to indicate or point towards a pathosis involving the Parotid gland or its duct. It was only after the CBCT imaging of the region revealed the poorly calcified accretion just buccal to the upper first molar tooth in the region of the Stensen's duct orifice, could the diagnosis be immediately and precisely established and correct therapy immediately instituted.

The small, poorly calcified distal ductal calculus had caused stasis and backup of saliva, leading to bacterial ascent from the oral cavity via the clogged ductal orifice into the duct and thence to the adjacent tissue space, namely the buccal space, resulting in a space infection which underwent periods of exacerbation and remission. The buccal space infection had also led to the formation of a chronic draining sinus through which purulent material discharged onto the skin of the cheek.

Salivary duct lithiasis is a condition characterized by the obstruction of the excretory duct of a major salivary gland due to the formation of calcareous concretions or sialoliths resulting in salivary ectasia and even provoking the subsequent dilation and inflammation of the salivary gland. Sialolithiasis accounts for 30% of salivary diseases and most commonly involves the submandibular gland (83 to 94%) and less frequently the parotid (4 to 10%) and sublingual glands (1 to 7%) [15].

Salivary calculi affecting the parotid gland are usually small, unilateral and are usually located in the duct rather than in the gland [16]. Most salivary calculi are small and usually less than 1 cm, but megaliths or giant calculi have also been reported.

Clinically, sialoliths are round or ovoid, rough or smooth and of a yellowish colour. They are composed of mineralized debris that accumulates within the duct lumen consisting mainly of calcium phosphate, carbon and trace amounts of magnesium, potassium and ammonia [17]. Salivary calculi grow by deposition at an estimated rate of 1 - 1.5 mm/year [15]. The exact cause of stone formation is unclear but it is felt to be the result of calcification of an intraluminal organic nidus such as dried secretion, bacterial colonies, or cellular debris. Secretion of saliva rich in calcium in the setting of partial obstruction of the duct caused by local inflammation or ductal injury are other theories of formation and promotion of ductal lithiasis. Dehydration, anticholinergic medications, certain systemic diseases and trauma may also be additional contributing factors [18].

Depending on the location and the size of the stone, the presenting symptoms vary [19]. Although most salivary stones are asymptomatic or cause minimal discomfort, larger stones may interfere with the flow of saliva and may cause pain and swelling. As a rule, sudden onset of post prandial pain and swelling which is episodic, associated with salivation during a meal is indicative of Sialolithiasis.

If left untreated, ductal salivary stones can cause secondary acute bacterial infection, which can ascend proximally and involve the gland, causing recurrent retrograde infection of the gland, chronic sialadenitis and glandular atrophy. Conservative treatment consists of oral analgesics and antibiotics. Surgical management includes removal or physical destruction/pulverization of the stone by means of salivary lithotripsy and sialoendoscopy. Recurrent or recalcitrant stones with resultant recurring chronic sialadenitis may warrant excision of the affected gland.

Sialoliths are often missed on conventional radiography due to two main reasons, the first, due to early stages of calcification which make them undetectable on radiographs and even on MSCT, and the second, due to superimposition and overlap of adjacent structures such as bones of the maxillofacial skeleton. The alternative option, Sialography is quite useful in delineating the exact size and location of stones within the salivary gland ducts [5]. The stone will be visualized as a filling defect within the duct. In some cases, contrast will not be able to pass beyond the stone. However, this modality is more invasive than routine radiographic or CT imaging and moreover, if active infection is suspected or present (as was in the case presented), sialography is contraindicated due to the risk of exacerbating the extent of infection.

CBCT technology can play an extremely important role in the early detection of Sialolithiasis. It is particularly well suited for use in dental offices and clinics for imaging of osseous structures of the craniomaxillofacial area for the following reasons [20,21]:

1. **Space consideration:** Being considerably smaller, less space occupying and more compact than MSCT equipment, CBCT equipment has a greatly reduced physical footprint and is also approximately one quarter to one fifth the cost of conventional CT. Hence it can be easily procured and installed in Dental offices and clinics where there might be space constraints.
2. **Rapid scan time:** Because CBCT acquires all projection images in a single rotation, scan time is comparable to panoramic radiography, which is desirable because artifact due to subject movement is reduced.
3. **Beam limitation:** Collimation of the CBCT primary x-ray beam enables limitation of the x-radiation to the area of interest.
4. **Image accuracy:** CBCT imaging produces images with submillimeter isotropic voxel resolution ranging from 0.4 mm to as low as 0.076 mm [14].
5. **Reduced patient radiation dose:** Comparison with patient dose reported for maxillofacial imaging by conventional CT (approximately 2000 mSv) indicates that CBCT provides substantial dose reductions of between 98.5% and 76.2%.
6. **Interactive display modes applicable to maxillofacial imaging:** CBCT units reconstruct the projection data to provide inter-relational images in three orthogonal planes (axial, sagittal, and coronal). In addition, because reconstruction of CBCT data is performed natively using a personal computer, data can be reoriented so that the patient's anatomic features are realigned. Image guided surgery is made easier [22].

In spite of wide and varied known applications of CBCT technology, there have been no documented literature reports so far, of its employment and application in the detection or diagnoses of Salivary gland or duct pathoses. This Case Report elucidates its sensitivity and specificity in detecting and correctly identifying small soft tissue accretions and calcifications and providing a precise three dimensional localization of even tiny sialoliths in relation to the nearby anatomic structures, thus bringing to light a whole new and valuable aspect of CBCT technology hitherto unexplored and yet another important area where it can prove to be a valuable asset.

Conclusion

Superior image quality, high interpretative accuracy, sensitivity and specificity leading to improved diagnostic ability together with reduced cost of procedure, reduced radiation hazard ensuring patient and operator safety, ability to capture the maxilla and mandible (or any of the desired specific maxillofacial field of interest) in a single rotation of the X-ray source, thus providing a quick scan process, makes CBCT the preferred imaging modality and a valuable option as a diagnostic tool in early detection of various oral pathologies, including Sialolithiasis. Its other superior features include the ability to suppress motion, metal and other artifacts and scatter and to overcome superimpositions. It greatly aids management by providing an accurate 3-D localization of the even tiny, poorly calcified sialoliths, overcoming superimpositions by bones of the maxillofacial skeleton. Small calcifications are easier to be identified on a CBCT scan than panoramic or intraoral radiographs and it is also shown to be superior to spiral CT in depicting soft-tissue calcifications.

The aim of this article was to provide an in-depth view and analysis of its particular utilization in this new arena, which can hence be employed extensively in the future, given its superiority over other diagnostic tools as has been described. In view of its superiority over other imaging modalities, it is proposed that CBCT may considered the ideal and most sensitive diagnostic imaging tool, hence the investigation of choice and the new 'Gold standard' in the detection, identification and localization of Salivary duct lithiasis. More extensive studies would however be required to be carried out with larger case series for a more evidence based conclusion.

Compliance with Ethical Standards

Disclosure of Potential Conflicts of Interest

The author of this article has not received any research grant, remuneration, or speaker honorarium from any company or committee whatsoever, and neither owns any stock in any company. The author declares that she does not have any conflict of interest.

Research Involving Human Participants and/or Animals

All procedures performed on the patients (human participants) involved were in accordance with the ethical standards of the institution and/or national research committee, as well as with the 1964 Helsinki declaration and its later amendments and comparable ethical standards.

Ethical Approval

This article does not contain any new studies with human participants or animals performed by the author.

Informed Consent

Informed consent was obtained from all the individual participants in this study.

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