ISSN No:-2456-2165

The Effectiveness of Cone Beam Computed Tomography (CBCT) in Assessing Sialolithiasis – A Review

[1.]Andria Dsouza
Intern
A. J. Institute of Dental Sciences
Mangalore, Karnataka, INDIA

[2.]Anchila Vincent
Intern
A. J. Institute of Dental Sciences
Mangalore, Karnataka, INDIA

[3.]Dr. Sitara Rathan
Assistant Professor, Dept.of Oral Medicine and Radiology
A. J. Institute of Dental Sciences
Mangalore, Karnataka, INDIA

[4.]Dr. Rashmi.K
Assistant Professor, Dept.of Oral Medicine and Radiology
A. J. Institute of Dental Sciences
Mangalore, Karnataka, INDIA

[5.]Dr.Muhsina C.H
Assistant Professor, Dept.of Oral Medicine and Radiology
A. J. Institute of Dental Sciences
Mangalore, Karnataka, INDIA

[6.]Dr.Devishree Rai
Assistant Professor, Dept.of Oral Medicine and Radiology
A. J. Institute of Dental Sciences
Mangalore, Karnataka, INDIA

[7.]Dr. Raghavendra Kini
HOD & Professor, Dept.of Oral Medicine and Radiology
A. J. Institute of Dental Sciences
Mangalore, Karnataka, INDIA

Abstract:- Sialolithiasis stands as the primary cause of enlargement in major salivary glands, including the parotid, submandibular, and sublingual glands. This condition primarily impacts people between the ages of 30 and 60, and it is more common in males. The most commonly observed symptom is intermittent gland swelling and discomfort triggered by eating. Various imaging methods, such as plain radiography, sialography, computed tomography (CT), cone-beam computed tomography (CBCT), ultrasonography (US), magnetic resonance imaging (MRI), and nuclear scintigraphy/positron emission tomography (PET), are utilised for diagnosing salivary gland lesions. Today, the rapid acquisition of 3D images via cone-beam CT(CBCT) has overcome time constraints associated with traditional medical CT and MRI. A swift and precise diagnosis can significantly enhance treatment effectiveness. CBCT has the potential to revolutionise dentistry with advantages like high-resolution imaging, shorter scan times, and reduced patient radiation exposure.

Keywords:- *Sialolithiasis, 3-Dimensional imaging, Cone beam Computed Tomography.*

I. INTRODUCTION

Sialolithiasis refers to the development of calcified deposits within the tissue or ductal network of both major and minor salivary glands. Specifically, submandibular calculi are more prevalent at 83% occurrence compared to parotid calculi at 10% and sublingual calculi at 7%. Sialolith formation is more prone to happen in the submandibular gland because of the extended and irregular path of Wharton's duct, the fact that the submandibular gland and its ductal system are positioned lower, the smaller size of the orifice concerning the duct's lumen.[1] Sialolithiasis is twice as common in males, making them more susceptible than females. This is probably due to higher salivary pH in males.[2]

Many patients suffering from sialolithiasis in a major salivary gland duct often report experiencing moderately intense discomfort, especially before, during, and after meals. This discomfort is attributed to psychological stimulation of salivary flow and is associated with the gland's swelling. The blockage of the duct hinders the natural saliva flow, leading to the buildup of saliva under pressure, resulting in pain and swelling. On occasion, this swelling can be widespread and mimic cellulitis. In rare instances, the presence of a stone may go unnoticed, with the only sign being a firm mass detectable within the duct or

ISSN No:-2456-2165

gland. In some cases, numerous small stones may be found obstructing the duct system.[3]

Diagnosing sialolithiasis is often straightforward by assessing its clinical characteristics. In many instances of submandibular calculus formation, a palpable stone can be detected through bimanual palpation of the floor of the mouth, moving from posterior to anterior [4]. The visibility of a sialolith depends on its level of calcification, causing it to either appear radiopaque or radiolucent. When they are visible, they typically exhibit a uniform radiopaque internal structure. However, in 20-40% of cases, they may lack sufficient calcification to be radiopaque and are termed "mucous plugs." Sialoliths come in various shapes, ranging from elongated cigar shapes to oval or circular shapes, featuring smooth edges. Their size can vary, ranging from slightly larger than a pinhead to over an inch in length, with a diameter of about 5 mm. They can occur as solitary or multiple formations.[1]

Cone beam computed tomography (CBCT) has emerged as a versatile 3D X-ray imaging method, experiencing substantial growth in dental radiology over the past two decades. CBCT effectively addresses the constraints of conventional two-dimensional dental imaging, allowing for precise visualisation of multi-planar details concerning maxillofacial bone structures and the adjacent soft tissues.[12] In this article, we aim to highlight the significance of employing CBCT for diagnosing Sialolithiasis.

II. METHODS AND METHODOLOGY

Data sources included electronic search engines such as Google and Chrome supplemented by automated searches on Research Gate, PubMed, Thieme & Symbiosis. Additionally, we conducted specific searches within prominent radiology journals using keywords like CBCT and sialolithiasis, as well as exploring imaging techniques for sialolithiasis. This comprehensive approach enabled us to compile articles spanning from 2009 to 2023.

III. DISCUSSION

Clinically, sialolith can resemble a mucous cyst or benign submucosal growth, initially painless and asymptomatic but causing pain when infected. Sialoliths form gradually through organic matrix calcification and are typically not visible on radiographs, thus posing a challenge in diagnosis. [6] X-rays are typically employed to identify hard tissue pathologies, but on occasion, they can also detect calcifications in soft tissues, with densities typically ranging between 100 and 400 Hounsfield units (HU). [20,21]

Diagnostic imaging is vital for identifying and planning the management of sialolithiasis, which can involve surgery or alternative treatments. In the past, various methods like plain radiography, sialography, computed tomography(CT), magnetic resonance imaging (MRI), and nuclear scintigraphy/ positron emission tomography (PET), were used for sialolith diagnosis.[4] Sialography, often combined with plain radiographs, served as the gold standard for assessing sialoliths.[7] Sialography is invasive and faces downside due to various issues, including cannulation difficulties, limited proficiency, patient non-compliance, and potential risks like radiation and allergies.[14] More recently, the combination of sialography with CT or MRI has allowed for three-dimensional gland duct representations.[7] CT sialography has drawbacks, such as the need for intravenous atropine to reduce contrast run-off and hinder ductal clearance in certain cases, radiation exposure, and the invasive nature of the procedure. MRI sialography comes with drawbacks, like its high cost, potential patient discomfort from claustrophobia and loud noises, contraindications for those with pacemakers or implants, and the ability to visualise only initial and secondary duct branches.[14]3D-Cone Beam Computed Tomography (CBCT) sialography is instrumental in achieving precise imaging and evaluating both salivary ostium catheterisation and main duct diameter prediction but also presents limitations such as invasiveness, allergies to contrast media, and inapplicability in acute infections. To address these challenges, we can turn to CBCT, a less invasive, cost-effective, and a simpler alternative. Acknowledging the limitations of the above-mentioned imaging modalities, let's delve into why CBCT can be regarded as a dependable approach for diagnosing sialoliths.

In 2009, Miloglu et al. conducted a study involving four cases of submandibular sialolithiasis, utilising flat panel-based CBCT for detection and evaluation. Their research underscored the significance of CBCT in accurately detecting, locating, and measuring submandibular sialoliths. While it didn't offer additional insights into the relationship between the sialolith and adjacent soft tissues, its precision in pinpointing the location and measuring the stones is noteworthy and shouldn't be underestimated.[13]

Based on research conducted by Drieseidler et al. using 29 CBCT images containing salivary calculi, it was found that CBCT is a reliable method for evaluating salivary calculi. The measurements of calculi using CBCT were consistently accurate and closely matched those obtained through ultrasonography. CBCT demonstrated diagnostic sensitivity and specificity levels that were equal to or greater than other diagnostic techniques. Due to its superior diagnostic accuracy while minimising radiation exposure, CBCT was deemed the preferred imaging modality for diagnosing salivary calculi.[8]

Lei et al.'s research findings suggest that CBCT holds promise in providing accurate guidance for the clinical management of salivary stones in the submandibular gland or Wharton's duct.[16]

In 2014, Schwarz D. and colleagues conducted a comparative study involving 43 patients to assess the effectiveness of sialendoscopy, sonography, and CBCT in detecting sialolithiasis. The findings indicated that CBCT demonstrated a superior ability to detect sialoliths in general, with a tendency to be more sensitive than sonography.[15]

ISSN No:-2456-2165

According to two case reports by Tassoker M et al. and Ozcan S et al., panoramic radiographs were initially used for diagnosis, but they couldn't confirm the presence of sialoliths. As a result, CBCT was employed to diagnose sialoliths and precisely determine their location. Their research demonstrated that CBCT showed a high degree of sensitivity in accurately presenting both the size and location of sialoliths [4].

Based on research conducted by Van et al., they found fifty salivary stones in the CBCT scan, leading to the conclusion that CBCT shows promise as an imaging modality with a high level of specificity and positive predictive value, as well as an even greater level of sensitivity and negative predictive value.[17]

Frankenberger et al.'s retrospective studies involving 46 patients led to the conclusion that CBCT displayed a noteworthy capacity for detecting or ruling out salivary stones. In assessments of specificity, sensitivity, and both positive and negative predictive values, CBCT exhibited superior performance compared to sonography [9].

According to a case report by Buch SA et al., it was determined that Cone Beam Computed Tomography (CBCT) offers a clear advantage compared to traditional sialography when it comes to visualising the salivary ductal system (Figure 1 & Figure 2). CBCT sialography can be considered the preferred method for showcasing the salivary ductal system and can serve as an alternative to conventional sialography.[18]

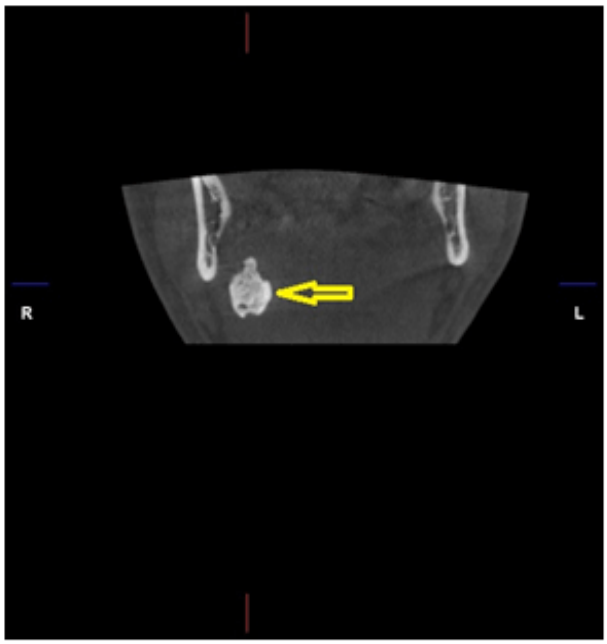

Fig 1: Coronal section of CBCT showing Right Submandibular sialolith (*Photo courtesy:* Buch SA, Babu SG, Hegde S, Rao S, Ajila V. CBCT Imaging of a Giant Sialolith (Megalith). Journal of Dentistry, Oral Disorders & Therapy [Internet]. 2019 Mar 11;7(1)

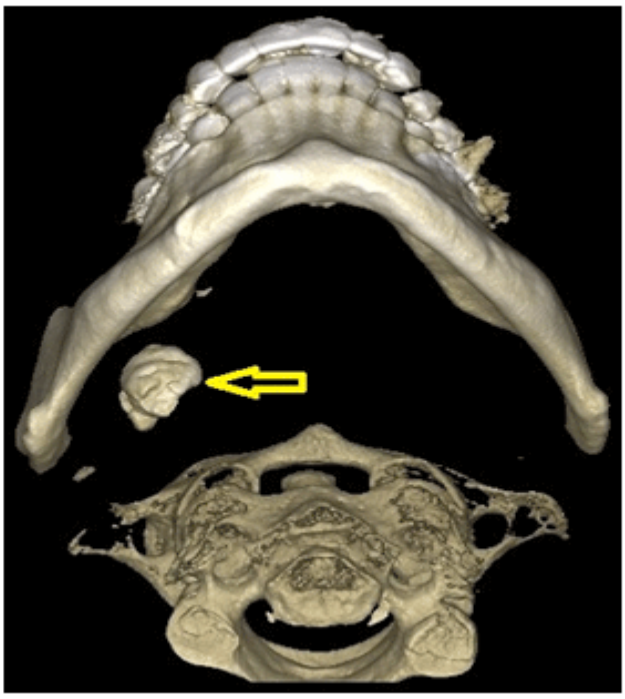

Fig 2: CBCT 3D reconstruction shows the position of the giant right Submandibular Sialolith. (*Photo courtesy:* Buch SA, Babu SG, Hegde S, Rao S, Ajila V. CBCT Imaging of a Giant Sialolith (Megalith). Journal of Dentistry, Oral Disorders & Therapy [Internet]. 2019 Mar 11;7(1)

Coston VV and his team conducted a study involving 32 patients diagnosed with submandibular sialolithiasis. Through the use of CBCT, they successfully detected a total of 51 salivary stones. Their research highlighted that preoperative CBCT offered a thorough understanding of individual stone configurations concerning the patient's anatomy. This, in turn, improved the ability to identify stones during sialolithotomy, leading to greater confidence when dealing with both proximal and hilar stones [11].

Initially, Mohsin and colleagues utilized a panoramic radiograph for a 47-year-old patient, revealing a sizeable radiopaque mass. To validate the diagnosis, they subsequently conducted a CBCT scan, which provided an accurate, multi-planar view of a well-calcified sialolith, assisting in the confirmation of their diagnosis.[19]

S. Rajbaran Singh and colleagues initiated their evaluation with sialography on a 62-year-old diabetic patient experiencing right-sided facial pain. On subsequent visits, they performed cone beam computed tomography (CBCT), which revealed multiple uniformly smooth calcifications (Fig.3 & Fig.4). Their assessment revealed that sialography presented drawbacks related to its invasive nature, potential cannulation complications, and the need for operator expertise. In contrast, they concluded that CBCT offered distinct advantages due to its exceptional isotropic spatial resolution. CBCT enabled precise localisation, measurement of calculi dimensions, and enhanced differentiation from other pathological conditions [10].

ISSN No:-2456-2165

Fig 3: CBCT shows multiple smooth Homogenous calcifications
(Photo Courtesy: Sandeepa Rajbaran Singh, Naome Joyce Mashigo. Cone beam computed tomography is used in sialolithiasis of the submandibular salivary gland. South African Dental Journal. 2023 Jul 4;78(04):218–8.)

Fig 4: Calcifications collectively measuring 12mm x 9mm x 8mm
(Photo Courtesy: Sandeepa Rajbaran Singh, Naome Joyce Mashigo. Cone beam computed tomography is used in sialolithiasis of the submandibular salivary gland. South African Dental Journal. 2023 Jul 4;78(04):218–8.)

Today, cone beam CT (CBCT) rapidly generates 3D images, overcoming the time limitations of traditional medical CT and MRI. CBCT is poised to transform the fields of oral and maxillofacial stomatology and radiology, offering advantages such as Improved patient safety with reduced radiation exposure, shorter scan times, and higher resolution. Its isotropic voxel resolution significantly enhances diagnostic capabilities compared to conventional CT. [5] CBCT provides an enhanced visualisation of the ductal system compared to traditional sialography. Furthermore, CBCT can be employed in patients with contrast allergies, acute infections, or orifice stones.[13] The CBCT sensitivity and specificity excel and are on par with the best outcomes of 3D imaging techniques such as medical CT and MRI sialography.[5] CBCT units offer a smaller size than medical CT scanners, come at a lower cost for both acquisition and operation, generate only a fraction of the radiation dose, and incorporate an open architecture that alleviates patient claustrophobia concerns.[13]

The primary drawback of using CBCT for diagnosing sialolithiasis is its inability to provide a clear view of soft tissue [4]. Additionally, extended time is necessary for the manipulation and interpretation of the images.[1] While diminished image quality and the presence of artefacts can diminish diagnostic value, CBCT remains a suitable method for adequately evaluating salivary calculi.[11]

IV. CONCLUSION

The effectiveness of Cone Beam Computed Tomography (CBCT) in diagnosing sialoliths appears to be promising based on research being conducted. It offers valuable data for determining the size and pinpointing the location of submandibular sialolithiasis. CBCT provides simplicity in operation, cost efficiency and sufficiency in achieving desired information. CBCT provides high-resolution 3D images that can help accurately locate and assess salivary gland stones, making it a significant tool for diagnosis.

REFERENCES

[1]. Karjodkar FR. Essentials of oral and maxillofacial radiology. New Delhi: Jaypee Brothers Medical Publishers; 2019
[2]. Li-Hui W, Chuan-Quan L, Long Y, Ru-Liu L, Long-Hui C, Wei-Wen C. Gender differences in the saliva of young healthy subjects before and after citric acid stimulation. Clin Chim Acta. 2016 Sep 1;460: 142-5.
[3]. B Sivapathasundharam. Shafer's Textbook of Oral Pathology – E-Book. Elsevier Health Sciences; 2016.
[4]. Tassoker M, Ozcan S. Two cases of Submandibular Sialolithiasis detected by Cone Beam Computed Tomography. IOSR Journal of Dental and Medical Science.2016;(15):124-129
[5]. Tyagi H, Awasthi UR, Katyal P, Rathore A. Cone beam computed tomography in sialography-report of two cases. Journal of Dental Specialities. 2016;4(1):65.
[6]. Matiakis A, Tzermpos F. Sialolithiasis of minor salivary gland: a challenging diagnostic dilemma. J Korean Assoc. Oral Maxillofacial Surgery.2021 Apr 30;47(2):145-148.
[7]. Veniaminivna Kolomiiets S, Oleksandrivna Udaltsova K, Andriivna Khmil T, Mykolaiivna Yelinska A, Anatoliivna Pisarenko O, Ihorivna Shynkevych V. Difficulties in Diagnosis of Sialolithiasis: A Case Series. Bull Tokyo Dent Coll. 2018;59(1):53-58.
[8]. Dreiseidler T, Ritter L, Rothamel D, Neugebauer J, Scheer M, Mischkowski RA. Salivary calculus diagnosis with 3-dimensional cone-beam computed tomography. Oral SurgeryOral Medicine Oral PathologyOral Radiology Endodontics. 2010 Jul;110(1):94-100.
[9]. Frankenberger K, AS Hosni, Yuldashev NP, Folz BJ. Evaluation of CBCT in sialolithiasis. Laryngo-rhino-otologie. 2018 Apr 1;

[10]. Sandeepa Rajbaran Singh, Naome Joyce Mashigo. Cone beam computed tomography is used in sialolithiasis of the submandibular salivary gland. South African Dental Journal. 2023 Jul 4;78(04):218–8.
[11]. Costan VV, Ciocan-Pendefunda CC, Sulea D, Popescu E, Boisteanu O. Use of Cone-Beam Computed Tomography in Performing Submandibular Sialolithotomy. J Oral Maxillofacial Surgery. 2019 Aug;77(8): 1656.e1-1656.e8. doi: 10.1016/j.joms.2019.04.014. Epub 2019 Apr 23.
[12]. Kaasalainen T, Ekholm M, Siiskonen T, Kortesniemi M. Dental cone beam CT: An updated review. Physical Medical: PM: an international journal devoted to the applications of physics to medicine and biology: official journal of the Italian Association of Biomedical Physics (AIFB) [Internet]. 2021 Aug 1; 88:193–217.
[13]. Miloglu Ö, Çaglayan F, Ezmeci T, Dagestan S, Demirtag Ö. Multiple cases of submandibular sialolithiasis were detected by cone beam computed tomography. J Dent Dent Fac Atatürk Uni 2010; 3 (20):189-193
[14]. Bickle I. Sialography | Radiology Reference Article | Radiopaedia.org [Internet]. Radiopaedia.
[15]. Schwarz D, Kabbasch C, Scheer M, Mikolajczak S, Beutner D, Luers JC. Comparative analysis of sialendoscopy, sonography, and CBCT in the detection of sialolithiasis. The Laryngoscope. 2014 Oct 24;125(5):1098–101.
[16]. CBCT on the Diagnosis of Sialolithiasis of Submandibular Gland [Internet]. journal 06.magtech.org.cn. [cited 2023 Sep 23].
[17]. van, K.H. Karagozoglu, G.A.M J. The value of cone beam computed tomography in the detection of salivary stones before sialendoscopy. International Journal of Oral and Maxillofacial Surgery. 2018 Feb 1;47(2):223–7
[18]. 18.Buch SA, Babu SG, Hegde S, Rao S, Ajila V. CBCT Imaging of a Giant Sialolith (Megalith). Journal of Dentistry, Oral Disorders & Therapy. 2019 Mar 11 [cited 2023 Sep 23];7(1)
[19]. Mohsin SF, Riyaz MA, Alqazlan AA. Detection and Management of Giant Submandibular Gland Sialolith. Pak J Med Sci. 2022;38(7)
[20]. Freire V, Moser TP, Lepage-Saucier M. Radiological identification and analysis of soft tissue musculoskeletal calcifications. Insights Imaging. 2018 Aug;9(4):477-492.
[21]. Kwee RM, Kwee TC. Calcified or ossified benign soft tissue lesions that may simulate malignancy. Skeletal Radiology. 2019 Jul 10;48(12):1875–90.