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REVIEW ARTICLE

Sialography: a pictorial review

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Abstract
Non-tumour inflammatory and obstructive salivary gland pathologies such as sialadenitis, sialolithiasis, sialadenosis, ductal strictures, etc. require precise radiological evaluation and mapping of salivary gland ductal system for better treatment outcome. Conventional sialography is considered as a useful and reliable technique in evaluation of salivary glands especially intrinsic and acquired abnormalities involving the ductal system and is useful for detection of non-radiopaque sialoliths which are invisible on routine plain radiographs. Primarily sialography is used as a diagnostic tool, additionally it plays an important therapeutic role as salivary gland lavage in cases of recurrent salivary gland infections and in obstructive salivary gland disorders by helping in clearance of mucous plugs or small sialoliths within the ducts. Recently, diagnostic performance of computed tomography (CT) sialography is being explored and has been reported to have high sensitivity in detection of small sialoliths and allows differentiation of sialoliths from other calcifications in glandular ductal system. Multiplanar three dimensional (3D) reconstructed CT images have been reported to play a key role in determination of anatomical location or extent of salivary gland disease without superimposition or distortion of structures. This review aims to discuss the disease specific applications of sialography and CT Sialography in particular for visualization of salivary gland disorders.

Keywords Computed tomography · Imaging · Salivary glands · Sialography

Introduction

Sialography is a non-invasive modality for the visualization of salivary gland parenchyma and the ductal system. Salivary gland abnormalities such as sialadenitis, sialolithiasis, sialadenosis, and ductal strictures are commonly seen in adults and prior to endoscopic or surgical treatment, precise radiological evaluation and mapping of salivary gland ducts is necessary for better outcome and prognosis [1, 2].

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In the mid-1990s, conventional sialography, first described by Carpy in 1904 was considered as a gold standard for the evaluation of ductal system. This technique involves identification, dilatation and cannulation of ductal orifices followed by injection of iodine-based contrast agent and is suitable in cases of chronic salivary gland infections. The salivary gland pathology can be identified based on the various sialographic appearances on the radiograph [3]. However, advent of ultrasonography and digital subtraction sialography, and cross-sectional imaging such as magnetic resonance (MR) sialography, and computed tomography (CT) has resulted in improved visualization of calculi, stenosis and strictures in the ductal system.

3D depictions of major salivary glands could be made possible by combining sialography with CT or MRI. Non-invasive MR sialography tends to replace conventional sialography because of widespread availability of 1.5 T and 3 T MR scanners, short acquisition times, increased signal to noise ratio and heavily T2 weighted pulse sequences. Unlike conventional sialography and other imaging modalities CT, cone beam computed tomography and positron emission tomography, MR sialography does not use ionizing radiation, contrast agent and cannulation of ducts is also not required and these advantages makes it a suitable choice for simultaneous exploration of parenchymal and ductal pathologies especially in patients with acute sialadenitis [1, 4]. Literature has revealed limitations that include low spatial resolution and sensitivity of MR sialography in detection of sialoliths when compared to conventional or CT sialography [5]. Varghese et al. suggested that small non obstructing sialoliths which are close to the orifice and small intraglandular stones are difficult to diagnose using MR sialography [6]. Another imaging modality, CT is being widely used by the researchers for the imaging of the major salivary glands, and is preferred in cases in which MRI is contraindicated. CT allows multiplanar 3D reconstruction or reformation of images, and multiplanar reformation has been reported to have an important role in determination of anatomical location or extent of salivary gland disease. Millimetre thin 2 mm axial CT slices are acquired from the skull base to the hyoid bone which are reformatted at 1 mm for display, and multiplanar reconstruction in coronal and sagittal planes is performed [1].

CT sialography, introduced in late 1970s and early 1980s allows precise mapping of filling defects or non-radiopaque sialolith within the ductal system, and enables their differentiation from other calcifications within the ductal system [7]. It allows better visualization of deep lobe of the parotid gland, mass lesions within or adjacent to the parotid gland, and these advantages make CT sialography superior to conventional sialography, and non-contrast CT to detect complex salivary gland pathologies. CT sialography with water-soluble contrast medium also has an important role as a therapeutic aid in recurrent infections by providing salivary lavage and in obstructive salivary gland pathologies by enabling clearance of mucous plugs or small sialoliths within the ducts [1, 7]. Literature has documented studies pertaining to conventional sialography and other advanced imaging modalities in the diagnosis of salivary gland pathologies, however, to our best knowledge limited studies have focussed on the applications of CT sialography, therefore, the aim of this review was to discuss the technique and disease specific applications of CT sialography in suspected cases of salivary gland diseases to have a better understanding of the variations in image characteristics that may occur due to pathology.

Technique

Conventional sialography

Sialography has been considered as a useful technique and has an important role in detection of salivary gland disorders. Water soluble contrast agents or medium are more suitable and safer for sialography when compared to oil-based iodinated contrast agent such as lipiodol as they have low viscosity, low surface tension, are more miscible with salivary secretions, and are rapidly excreted after the procedure. Moreover, they require less injection pressure for glandular filling thereby resulting in less pain and discomfort to the patient [8, 9]. Water soluble iodinated contrast agents are available as (i) ionic monomers or dimers referred to as high osmolar contrast media for example diatrizoate (hydropaque, urografin, and renografin), iothalamate (conray), (ii) non-ionic monomers or dimers referred to as low osmolar contrast media for example, iohexol (omnipaque), iopamidol (ultravist), iopromide (isovue, iopamiro, iopamiron, niopam). Water soluble, non-ionic, iodinated contrast agents do not dissociate into charged particles, tend to have low osmolality, and are less toxic with low incidence of adverse reactions on injection than ionic contrast agents [9]. Few clinicians prefer to use oil-based iodinated contrast agents as they remain in the salivary gland ducts for longer duration thereby producing satisfactory degree of opacification, but extravasation of oil-based contrast agent may lead to severe foreign body reactions and necrosis or fibrosis of salivary gland parenchyma [8, 9].

For conventional sialography, patients with clinical evidence of salivary gland non-tumour pathology or presence of parotid or submandibular gland masses are made to undergo baseline or scout lateral oblique and anteroposterior radiographs of the involved major salivary gland to assess the presence of radiopaque calculi before injection of the contrast agent. For parotid gland, anteroposterior and true lateral radiographs are preferred, however, oblique views can be used in conjunction with lateral views for depiction of spatial relationships. For submandibular gland, true lateral and oblique lateral views are preferred and mandibular occlusal radiograph can be taken for evaluation of intraoral part of the duct and to determine location and position of the salivary stone. The oral end of salivary gland ductal opening is dilated using graded silver lacrimal probe and cannulated by insertion of intravenous catheter or cannula into the ductal orifice. In cases where ductal orifice is difficult to locate and to facilitate insertion of catheter, salivary stimulation can be performed by application of citric acid crystals on the tongue [3, 10].

When catheter/cannula is in fixed position then up to 2.5 mL of water-soluble iodinated contrast agent is injected in the duct through a small polythene tube until the patient felts fullness or discomfort. For parotid gland, 2–2.5 mL of contrast, and for submandibular gland, 1–1.5 mL of contrast is usually administered. After the instillation of contrast agent, lateral and oblique radiographs are taken and after completion of the procedure patient is made to suck on a lemon juice for evacuation of contrast agent and post procedure radiograph is usually taken after 5 min to confirm the evacuation of contrast agent or presence of any residual contrast agent [10].

CT sialography

The technique of CT sialography is similar to conventional sialography and it is the most advantageous technique due to ease of injection of contrast agent when the patient is lying down on the couch. Instillation of intravenous water-soluble contrast agent provides better soft tissue evaluation especially in cases of mass lesions within the gland. Literature reports have suggested that injection of water-soluble contrast dye mixed with 50% saline produces better quality images. In CT sialography, scanning is initiated from the level of the hyoid bone at a gantry tilt of 5° for submandibular glands and 20° for the parotid glands. Acquired 2 mm thin slices data in axial plane can be converted into non-axial coronal, sagittal and oblique planes [11].

After the procedure, evacuation of contrast agent is done by making the patient suck on lemon juice however, in 1970s and 1980s slower CT scans necessitated the intravenous administration of atropine to avoid premature run off of contrast, impaired ductal opacification, to improve retention of contrast in the ductal system and to prevent delayed ductal emptying after the procedure due to longer scan time. These disadvantages were overcome by introduction of ultrafast CT combined with 3D image processing which offers improved and precise visualization of anatomical details and salivary gland disease with reduced incidence of motion artefacts and premature run off of contrast. Additionally, 3D image processing allows simultaneous assessment of extra and intraductal salivary gland disease and might be useful in characterizing the status of the ductal system in inflammatory salivary gland diseases [11].

For CT sialography, precautions should be followed while performing scan for patients with medical history of cardiac disease and on anticoagulants such as aspirin, warfarin or on antifibrinolytic therapy. Anticoagulants should be stopped three days prior to the procedure so as to prevent the haematoma formation which may occur if the physician takes longer time up to 1 h to locate the submandibular duct orifice [12].

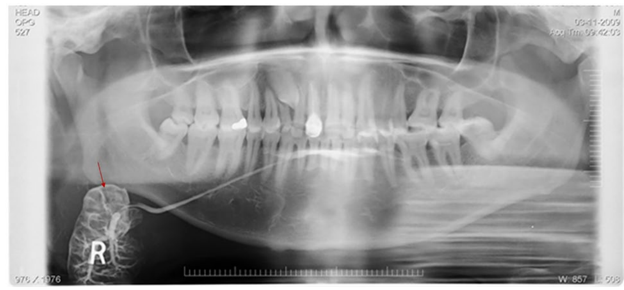

Fig. 1 Panoramic sialogram reveals normal right submandibular gland giving "bush in winter" appearance. Ossified portion of the hyoid bone is seen superimposed upon the lower part of the gland appearing as ectopic calcification

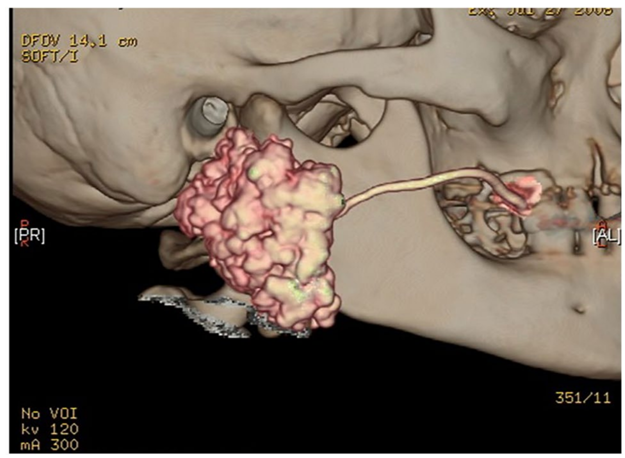

Fig. 2 Reconstructed 3D CT sialographic image shows normal right parotid gland

Discussion

Normal sialogram

Normal sialogram of a major salivary gland presents as an "leafless tree", "tree in winter" or "bush in winter" appearance (Figs. 1, 2). The primary duct is uniformly fine without any presence of terminal dilatation. Submandibular ducts are much shorter and wider than parotid duct thereby increasing the risk of recurrent infections in the parotid. Figure 3 reveals normal right submandibular gland with sublingual gland opacification.

Accessory salivary gland ducts

Accessory salivary glands and their ducts are rarely encountered normal variants and represent an ectopic salivary tissue separated from but in close proximity to the main gland. An accessory parotid gland has been reported in 21% of the general population and is usually present in close proximity to the Stenson's duct, lying on the masseter muscle but away from the main parotid gland [13]. Accessory submandibular gland and ducts are uncommon anatomical variants and incidence in general population has not yet been reported (Fig. 4a). Radiographically, they give branched tree appearance gradually tapering towards the periphery from the main parotid or Whartons duct (Fig. 4b) [14]. The presence of inflammatory or

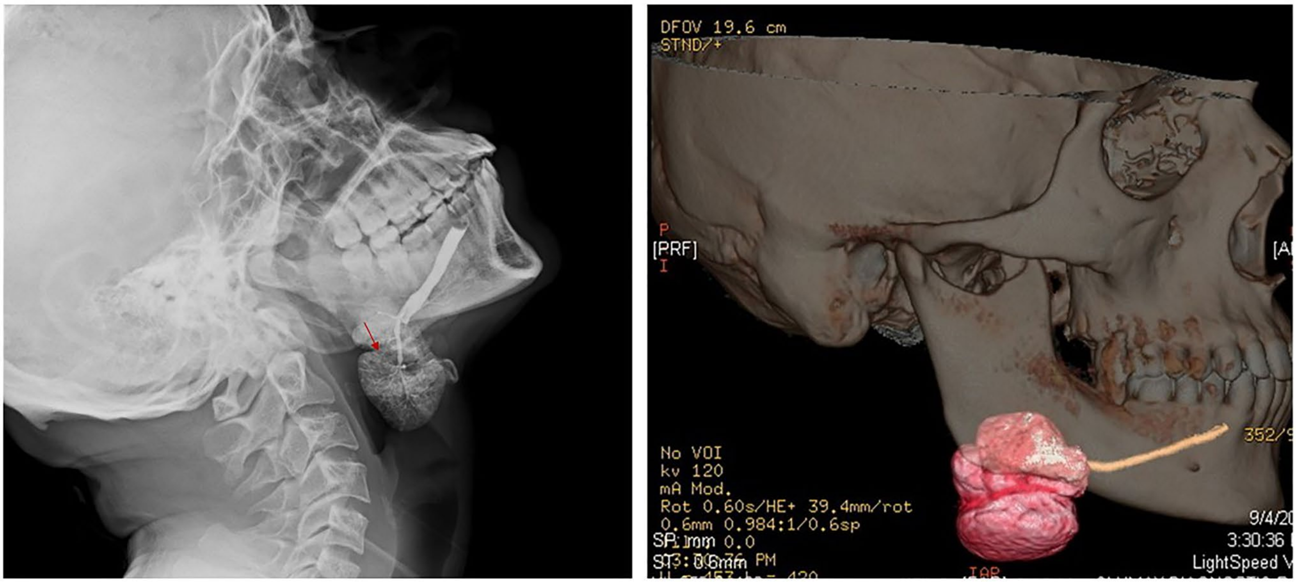

Fig. 3 Lateral and reconstructed 3D CT sialo graphic image shows normal right submandibular gland with sublingual gland opacification. Lateral view reveals uniformly and completely filled main duct with branching duct structure tapering gradually towards the periphery giving "bush in winter" appearance

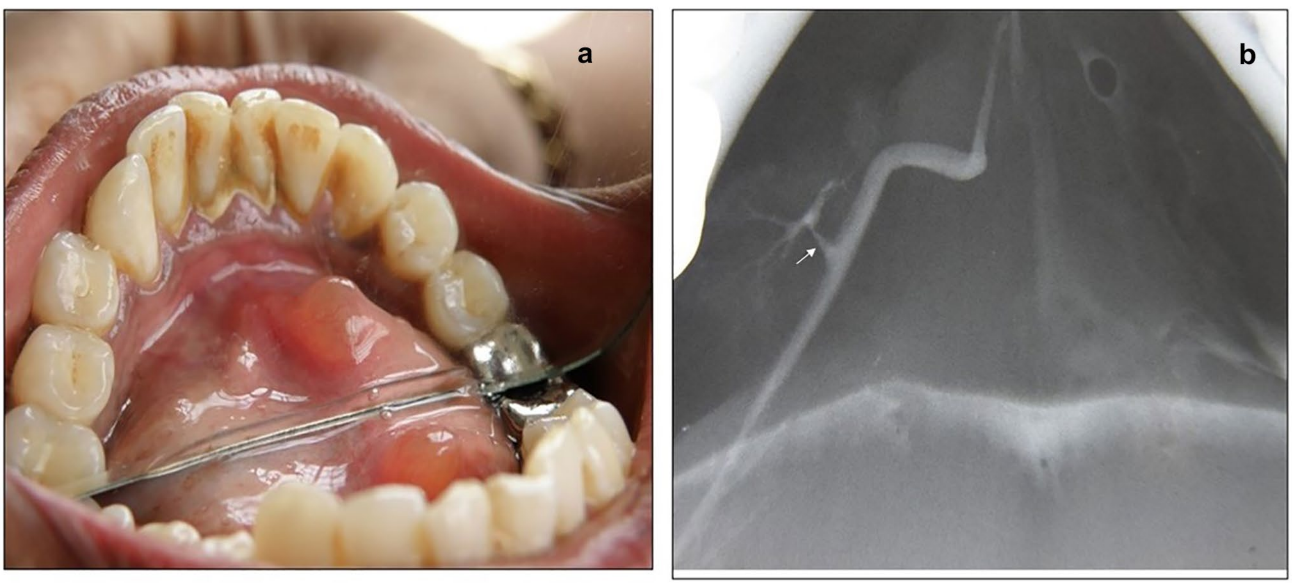

Fig. 4 **a**, **b** Accessory submandibular gland duct. Mandibular occlusal radiograph reveals branched tree appearance of accessory duct gradually tapering towards the periphery from the Whartons duct

obstructive pathologies is rare in the accessory salivary gland ducts, and often go unnoticed in majority of cases but they should be considered in the differential diagnosis of pathologies involving parotid or submandibular region, and surgeons should have thorough understanding of such rare anatomical variations to prevent complications [13].

Disease-specific applications of CT sialography

Sialolithiasis

Sialolithiasis is the most common salivary gland disorder found in patients between 30 and 60 years of age and is characterized by formation of salivary calculi or sialolith inside the salivary gland duct [15]. Literature has revealed 80 to 90% cases of sialolith in the submandibular gland which may be due to more viscous, mucous, and alkaline secretions from the submandibular gland duct or Whartons duct [16]. The patient reports with the complain of pain and recurrent swelling in the parotid or submandibular region which becomes more pronounced during eating because of impaired salivary flow due to obstruction in the salivary gland duct. In chronic cases, gland undergoes atrophy and patient reports no symptoms unless there is secondary infection proximal to the ductal obstruction resulting in bacterial sialadenitis [15–17].

Multimodal imaging modalities are available to evaluate the presence of salivary gland stone. Radiographically, sialoliths may appear as radiolucent or radiopaque depending upon the degree of calcification. In a study by Suleiman et al., out of 38 patients, anteroposterior view was helpful in detection of calculi in 58% of patients, and 71% calculi which were radiopaque were detected when anteroposterior view was combined with an intraoral view in which radiographic film is placed between the teeth and buccal mucosa [18]. Calcified radiopaque sialoliths require decrease in exposure by 50% for better visualization on occlusal radiographs. Sialography is useful in detection of sialoliths which are undetectable by plain radiographs or if they are radiolucent. When compared to conventional sialography, CT sialography allow precise evaluation of location and size of sialoliths which are small and non-radiopaque, and multiplanar 3D reconstructed images allow clear visualization of salivary gland stone without superimposition of anatomical structures. In addition, CT scan is a useful diagnostic aid in follow up of patient after sialendoscopy or lithotripsy procedure to confirm presence of any residual nidus of the sialolith [17]. On CT images, sialoliths appears as single or multiple small hyperdense structures with variable shape i.e. long cigar, oblong, round or oval. The radiopaque contrast agent usually flows around the sialolith and fills the duct proximal to the obstruction. It has been documented that 80% parotid and 20% submandibular gland sialoliths are poorly calcified, "mucous plugs" which appear as partial or complete filling defect/void (Fig. 5), and CT sialography is a modality of choice in such case scenarios [15, 16]. In Fig. 6, Axial CT sialogram of the patient depicts minimal calcified sialolith presenting as partial filling defect/void in right parotid duct. In addition, CT sialography helps in differentiation of radiopaque sialolith from calcified lymph nodes which appear as cauliflower shaped, and phleboliths which often exhibit a radiolucent centre [17, 18].

Salivary gland stenosis

Salivary gland stenosis or strictures ductal obstruction or narrowing of the duct due to chronic irritation, trauma or presence of intraductal growth. They are second most

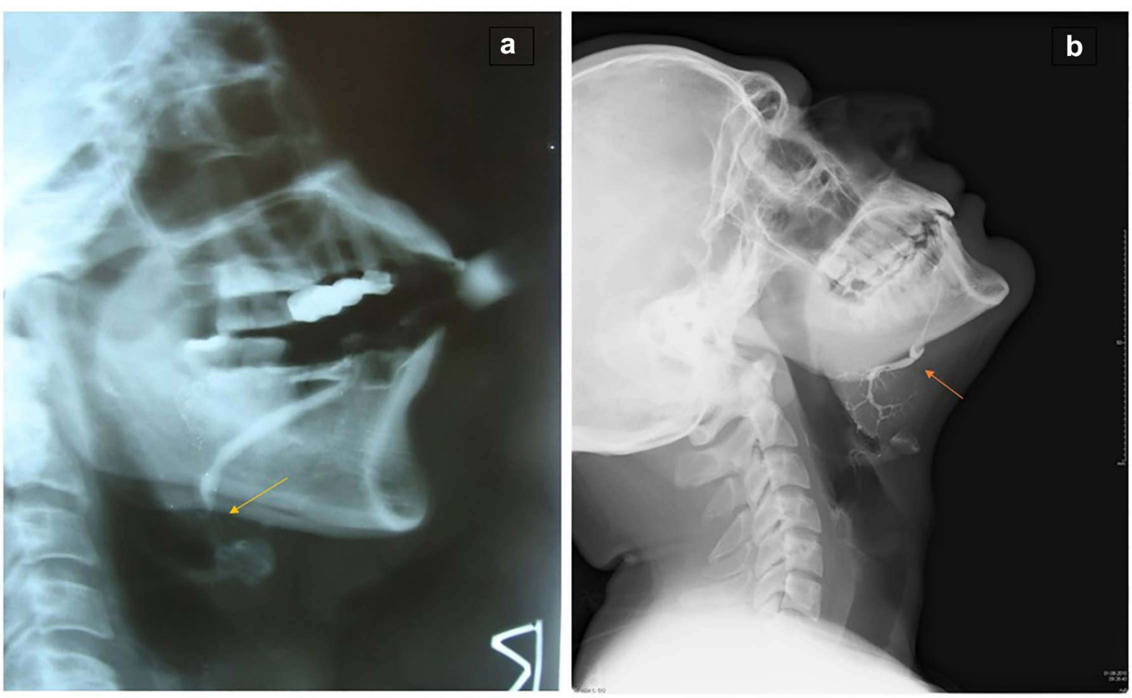

Fig. 5 Lateral view shows **a** lith complete filling defect in the posterior end of the main submandibular duct and ductal dilatation is evident beyond the lith. **b** Lith meniscal sign

Fig. 6 Axial CT sialogram demonstrates minimal calcified sialolith presenting as partial filling defect/void in right parotid duct

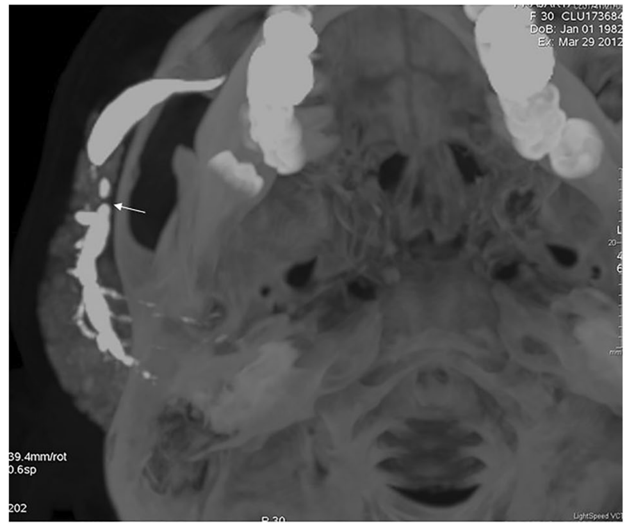

Fig. 7 CT sialogram reveals stricture in right parotid duct which appears as filling defect and dilatation of duct distal to stricture

common cause of obstruction after sialolith in the salivary glands. Literature has revealed that around 70–75% strictures involve the parotid gland and 25–30% occur in submandibular glands [19]. Stenosis/strictures in both the glands result in obstruction in the flow of saliva through the duct and mucous plug is formed behind the stricture resulting in chronic inflammatory salivary gland disease. Various diagnostic modalities such as ultrasonography, MRI and CT can assist in precise mapping of the stricture in the ductal system. Use of sialography for ductal stricture has been considered as both diagnostic and therapeutic aid because of its potential to cause dilatation of the distal duct resulting in relieving of stricture [3]. Contrary to this, few authors believed that sialography should not be the first choice for strictures because of use of contrast medium and radiation exposure and they suggested ultrasonography as an initial diagnostic investigation as it is non-ionizing and provides clear overview of the entire ductal system [19]. Becker et al. in their study has reported that MR sialography has high sensitivity of 100% and specificity of 93 to 98% in diagnosis of strictures [20]. By our search clinical applications of CT sialography in detection of strictures are limited and they usually appear as filling defect or voids in the duct on the sialogram (Fig. 7). Future demands more research to explore the diagnostic performance of CT sialography in detection of stenosis or stricture.

Sialodochitis

Sialodochitis is an inflammation of the ductal system of parotid or submandibular glands. Sialodochitis fibrinosa well termed as Kussmaul disease is a rare salivary gland entity which is characterized by recurrent painful salivary gland swellings due to the mucofibrinous plugs. This condition is associated with decreased salivary gland flow, thick secretions from Stenson's or Whartons duct and patient may give history of an allergic reaction [21]. Sialogram often reveals radiopaque large sialolith at posterior end of the main duct and segmental intermittent sacculation or dilatation and stricture of the main and secondary ducts beyond the lith termed as "sausage-link appearance." (Figs. 8, 9).

Sialadenitis

Sialadenitis is an inflammation of the major salivary glands commonly involving acino parenchyma of the parotid gland. Sialadenitis can be acute, chronic or recurrent, acute sialadenitis may result due to retrograde bacterial (*Staphylococcus aureus* and *Streptococcus viridans*) or viral infections (mumps or cytomegalovirus) whereas chronic sialadenitis may occur due to ductal obstruction or could be associated

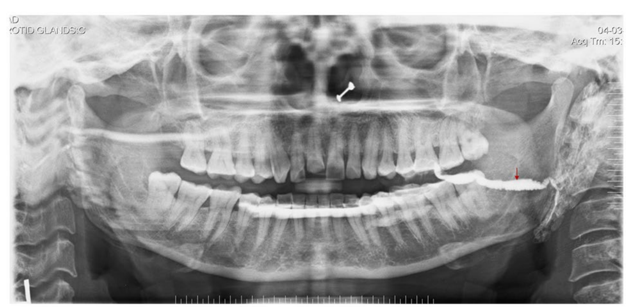

Fig. 8 Panoramic sialogram shows segmental dilatation and stricture in relation to left Stenson's duct, sausage link appearance suggestive of sialodochitis

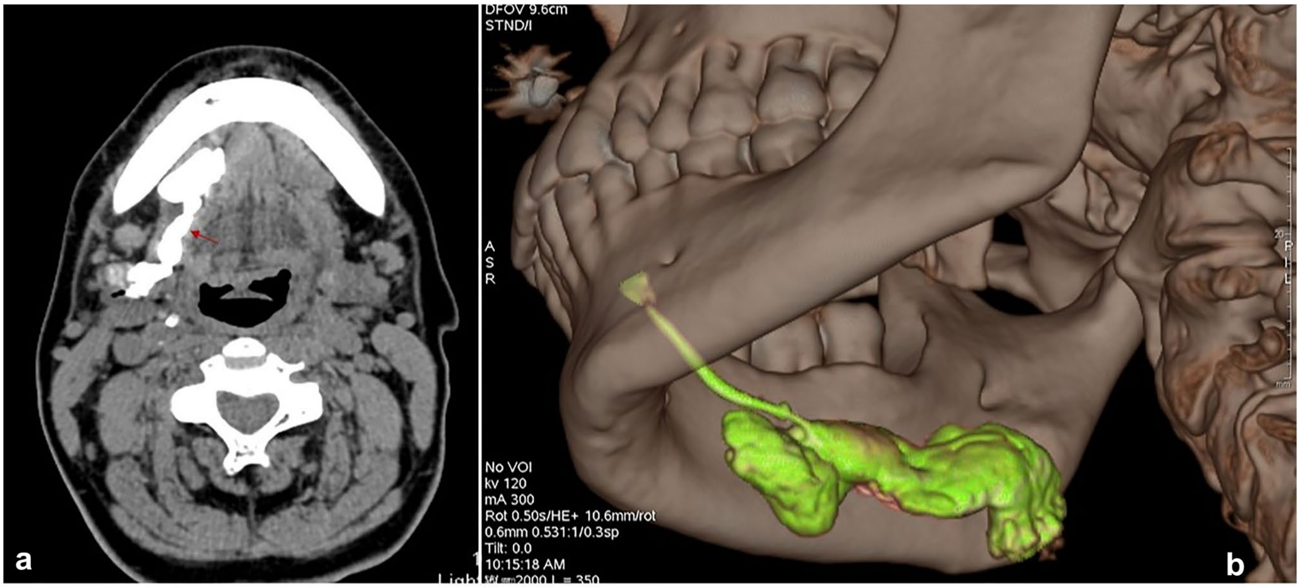

Fig. 9 **a** Axial CT sialogram and **b** 3D volume rendered sialographic image shows sausage link appearance of right Whartons duct

with certain autoimmune conditions such as Sjogren's syndrome [22]. Chronic bacterial sialadenitis has been studied to result from decreased salivary flow due to stricture, stenosis, or stone in the main duct and this eventually results in ascending infection. Patient often complains of intermittent, recurrent episodes of painful swelling of unilateral or bilateral salivary gland and might aggravate on intake of meals. During the painful episodes, pus may be expressed from the ductal orifice and milking of the gland to stimulate saliva may cause pain. Painless swellings are often encountered in autoimmune sialadenitis unless secondarily infected. Untreated or advanced sialadenitis may be associated with sialolithiasis, sialodochitis, abscess and fistula formation [23]. Sialography is contraindicated in acute infections of the salivary glands as it may lead to extravasation of contrast agent causing an allergic reaction or severe pain. However, sialography has an important role as a therapeutic aid in obstructive sialadenitis as it helps in clearance of mucous plugs in the ducts and prevents the occurrence of recurrent infections [3].

Sialogram reveals dots or blobs of the contrast agent within the gland, and this appearance is termed as "sialectasia" or apple tree in blossom." In the early stage, "punctate sialectasis" is evident which refers to spherical collections of contrast medium less than 1 mm in diameter. Main duct and interglobular ducts are normal (Fig. 10). As the condition progresses, collections of contrast medium increase in size and become globular, around 1–2 mm in diameter (Fig. 11) and cavitary more than 2 mm in diameter. Sialectasis caused by an inflammation of the glandular tissue thereby leads to saccular dilatation of the acini and of the terminal ducts

Fig. 10 Panoramic sialogram shows spherical collections of contrast agent less than 1 mm in diameter suggestive of "punctate sialectasis." Main duct and interglobular ducts are normal

however, the main duct is normal. Radiographically, another inflammatory condition of the ducts, sialodochitis should be differentiated from sialadenitis which involves dilatation of the main duct and interlobular ducts, giving "sausage link appearance" whereas in sialadenitis main duct and interlobular duct appear normal [24]. CT sialography has been shown to have sensitivity of 57.14% and specificity of 100% in diagnosis of sialadenitis secondary to ductal obstruction [25].

Sjogren's syndrome

Sjogren's syndrome also termed as autoimmune sialadenitis is a chronic autoimmune disorder characterized by lymphocytic infiltration of exocrine glands predominantly salivary and lacrimal glands, resulting in symptoms of

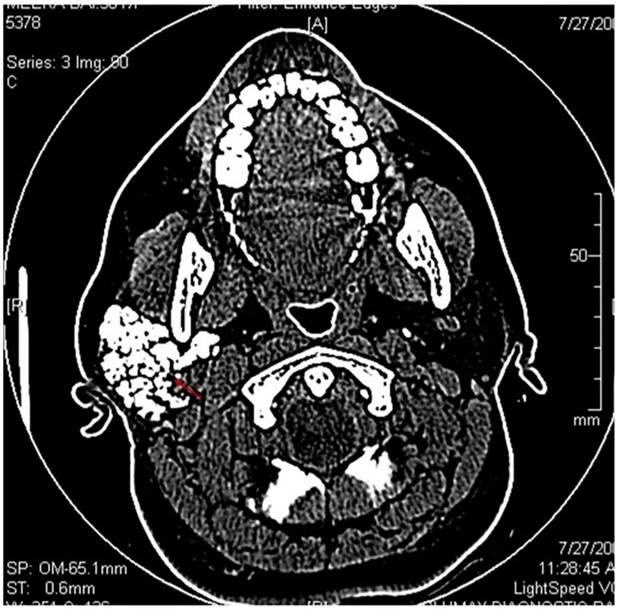

Fig. 11 Axial CT sialogram shows enlarged right parotid gland and globular (larger spherical) collections of contrast agent distributed throughout the gland

dry mouth (xerostomia) and dry eyes (keratoconjunctivitis sicca). Sjogren's syndrome has been reported to commonly involve the parotid glands with 90 to 95% female prevalence aged between 40 and 60 years [26]. Genetic, environmental, immune system dysfunction and hormonal alterations have been reported to be associated with occurrence of this condition and patient often reports with the complain of mucosal dryness and sometimes recurrent parotid gland enlargement [26]. Presumptive diagnosis of Sjogren's syndrome is usually based on patient's history, clinical examination, American European Consensus Group (AECG 2002) classification criteria, autoantibody tests, and minor labial salivary gland biopsy [27]. However, further confirmation by various imaging modalities is essential to rule out the exact cause of xerostomia.

Imaging plays a very important role in diagnosis and in functional assessment of salivary glands in various salivary gland pathologies, however, in Sjogren's syndrome selection of imaging technique is largely influenced by the stage of the disease. As the disease progresses, in intermediate stage multiple small cystic areas within the parotids and in later stage fatty degeneration, large cystic or solid masses stages are observed. Cystic masses indicate destroyed gland or collection of saliva and solid masses are the lymphoid aggregates that result in the glandular destruction. Interpretation of fatty changes within the glands is necessary to differentiate Sjogren's syndrome from other conditions such as medications or systemic diseases that result in xerostomia [1, 28]. Although these changes are well appreciable on MRI and CT images, however, in few cases accurate interpretation of disease characteristics on the images for the presence of Sjogren's syndrome may become challenging, as a result patients are either misdiagnosed or are left untreated.

To this consideration, CT sialography is a preferable option as it provides thin multiplanar reconstructed 3D images of the ductal system with high spatial resolution. Four stages of sialography were described by Rubin and Holt based on collections of the contrast agent within the gland as (i) stage 1 punctate (less than 1 mm), (ii) stage 2 globular (1 to 2 mm) spherical collections of contrast medium, (iii) stage 3 cavitary (greater than 2 mm) larger and irregular collections of contrast medium, and (iv) stage 4 destructive sialectasis due to complete destruction of glandular parenchyma. "Cherry blossom" or "apple tree in blossom" or "branchless fruit laden tree" representing multiple globular or cavitary collections of contrast medium is characteristic of Sjogren's syndrome (Fig. 12a, b). In initial stages of Sjogren's syndrome, main duct appears normal and intraglandular ducts may be less evident. Widespread dots or blobs of the contrast agent is seen throughout the gland and this snowstorm appearance or punctate sialectasis in Sjogren's syndrome should be differentiated from sialadenitis [3, 28]. In Sjogren's syndrome weakening of epithelium lining the intercalated ducts causes extravasation of the contrast agent out of the duct whereas in sialadenitis glandular inflammation leads to saccular dilatation of the acini [3].

Salivary gland tumours

Salivary gland tumours are rare and account for 3–6% of head and neck tumours. Majority of salivary gland tumours are benign and usually present as painless solitary masses [29]. 70% salivary gland tumours have been reported to occur in parotid gland, 10% in submandibular and less than 1% in sublingual gland. Of 70% tumours encountered in parotid gland, 50 to 60% are pleomorphic adenoma, 20 to 30% are Warthin's tumour and around 10% are mucoepidermoid carcinomas [30, 31]. Salivary gland tumours are diverse group of neoplasms which show variation in location, origin and malignant potential. It has been hypothesized that smaller the involved salivary gland, there are higher chances of tumour of being malignant [31]. Imaging plays an important role in establishing diagnosis, in delineation of location and extent of tumours, and invasion into adjacent anatomical structures. CT and MRI are modalities of choice in diagnosis of suspected salivary gland masses, and in detection of lesions affecting deep lobe of parotid gland and minor salivary glands. It has been suggested that CT and MRI may differentiate benign from malignant tumours, Warthin's tumour from pleomorphic adenoma and distinguishes solid from cystic masses. On CT images, pleomorphic adenoma is seen as round homogeneous mass

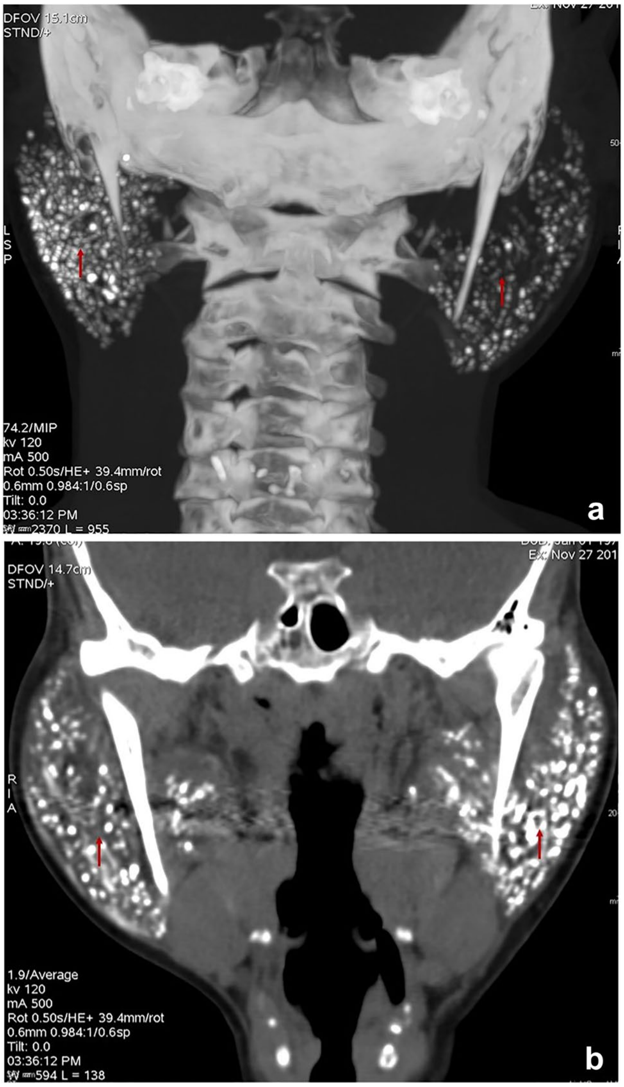

Fig. 12 **a** Coronal CT sialogram demonstrates multiple scattered small spherical collections of contrast medium distributed throughout the parotid glands, snowstorm appearance or "punctate sialectasis". **b** Multiple globular collections of contrast medium within the parotid glands, characteristic "cherry blossom" appearance of Sjogren's syndrome

that has slightly higher density than the gland and Warthin's tumour may have soft tissue or cystic density. Malignant salivary gland tumour usually appears as irregular homogeneous mass density on CT images, and becomes more radiopaque than glandular tissue with contrast enhanced CT [31, 32].

Kakimoto et al. studied CT and MRI features pleomorphic adenoma in 50 patients and found that on contrast enhanced CT images, pleomorphic adenoma showed peripheral enhancement but capsule was more appreciable on MRI images [33]. On CT or MRI images, benign salivary gland tumours appear to have well-defined margins, however tumours involving submandibular gland may get obscured

Fig. 13 Axial CT sialogram shows ball in hand appearance, a well-defined, homogeneous hyperdense mass within the left parotid gland suggestive of an intrinsic tumour

due to higher or equal density of gland and neoplasm. Therefore, for evaluation intravenous contrast enhancement is required during CT or MRI examination as it makes the tumour more radiopaque than adjacent glandular structures. Imaging of salivary glands for suspected parotid masses is challenging in young patients as salivary glands contains less fatty tissue, as a result parotid mass lesions may remain go undetected. Therefore, plain CT should be followed by CT sialography for proper evaluation and further management [33].

CT sialogram reveals intrinsic tumours of parotid or submandibular gland as space occupying mass within or adjacent to the salivary gland, extensive ductal displacement and ducts may appear stretched or curved around the tumour creating " ball in hand" appearance (Fig. 13). Sialogram may also reveal an area of underfilling within the gland due to ductal compression by the tumour and retention of contrast medium within the displaced ducts during the emptying phase.

Conclusion

CT sialography is a useful and valuable technique for precise mapping of surgical landmarks and ductal abnormalities before parotidectomy or sialendoscopic procedure. Studies have reported high sensitivity of CT sialography in detection of non-radiopaque and small sialoliths, however, literature has revealed limited applications of CT sialography in diagnosis of inflammatory and obstructive salivary gland diseases and, this necessitates future more researches in this domain.

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Data availability Raw data was generated at a the Manipal Hospital, Bangalore, Karnataka, India. Derived data that support the findings of this study is avaliable from the corresponding author upon request.

Declarations

Conflict of interest The author declare that there is no conflict of interest.

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