Standardization of terminology, imaging features, and interpretation of CBCT sialography of major salivary glands: a clinical review

Ragda Abdalla-Aslan, DMD/Naama Keshet, DMD/Yehuda Zadik, DMD/MHA/Doron J. Aframian, DMD, PhD/Chen Nadler, DMD, PhD

Sialography combined with cone beam computerized tomography (sialo-CBCT) is an imaging technique that demonstrates the ductal system of the major salivary glands and allows evaluation of gland function. This review describes the sialo-CBCT technique, terminology, common pitfalls and limitations, as well as radiographic features and suggested pathogenicity of various salivary gland disorders, based on 1,758 sialo-CBCT examinations conducted over the last decade in one institution, and the current literature. The adoption of standardized terminology is proposed to prevent miscommunication, facilitate formulation of differential diagnoses, and thereby promote patient management: (1) Sialo-CBCT requires specific training, and operator experience is required for adequate glandular filling with minimal extravasation; (2) Limit injection-to-scan time to avoid premature emptying; (3) The sialo-CBCT report should include a description of the morphology of the primary duct as well as the secondary, tertiary, and descending branches, the maximal branching level, the presence of sialectasis, overall glandular size, and parenchymal findings; (4) Functional evaluation is based on assessment of iodine clearance in the post evacuation image; (5) Sialectasis and ductopenia are the main findings in Sjogren syndrome and recurrent juvenile parotitis; (6) Sialodochitis with or without fillings defects or hyperdense calcifications characterize obstructive sialadenitis and sialolithiasis; (7) The findings following radioactive-iodine-induced damage are similar to obstructive sialadenitis, with atrophy in late stages; (8) In chronic graft-versus-host disease (cGVHD), variable presentations of ductopenia, sialectasis, and sialodochitis may be evident; (9) The red flags indicating a space-occupying lesion include areas of no filling, spaying of ducts, and primary duct deviation. (Quintessence Int 2021;52:728–740; doi: 10.3290/j.qi.b1492217)

Key words: cone beam computed tomography, parotitis, salivary glands, sialadenitis, sialography, Sjogren syndrome

Diagnosis of salivary disorders begins with a thorough medical history and physical examination, followed by laboratory tests and imaging. Radiologic examination is required to confirm the provisional diagnosis, identify pathologic regions within the glandular structure, and aid in selecting the appropriate therapeutic strategy.¹

Sialadenitis is a common obstructive or inflammatory non-tumor salivary gland disorder.²,³ The main causes of obstructive disorders are sialolithiasis, mucous plugs, foreign bodies, and anatomical variations.⁴,⁵ Obstructions block salivary flow causing stasis in the ductal system, leading to persistent swelling, inflammation, and infection.⁶ Clinical symptoms include recurrent painful, meal-time swellings in the region of the affected gland. The most common inflammatory salivary gland disease is Sjogren syndrome (SS), a systemic autoimmune disorder associated with inflammation of epithelial tissues, particularly exocrine glands, characterized by xerostomia and kerato-conjunctivitis sicca.⁷ SS may be complicated by secondary obstructive features, because hyposalivation may enable retrograde entry of bacteria into the ducts, which then become infected and
swollen. Patients may present with symptoms of inflammation or obstruction (either primary or secondary), such as dry mouth, recurrent swelling, and infection.

Dental health practitioners are usually the first professionals to encounter patients with complaints of a dry mouth and recurrent swellings and infections of the salivary glands. Dry mouth has a significant impact on oral function, dental decay, oral infections, and quality of life. Therefore, dental practitioners need to be familiar with the etiologies of salivary gland disorders and the role of sialo-CBCT in order to improve patient management.

The aim of this pictorial review is to characterize the radiographic features of cone beam computerized tomography sialography (sialo-CBCT) images of a wide range of nontumor salivary gland disorders related to sialadenitis, drawn from 1,758 sialo-CBCT examinations conducted in a single institution between the years 2012 and 2020, supplemented by a pertinent literature review. Imaging approach in nontumor salivary gland disorders is addressed first, followed by a description of the sialo-CBCT technique, terminology, and imaging features in different salivary gland disorders, including SS, recurrent juvenile parotitis, chronic obstructive sialadenitis, sialolithiasis, iodine-induced sialadenitis, graft-versus-host disease, and suspected space-occupying lesions. For each disorder the clinical, pathophysiologic, and radiographic features are discussed.

**Imaging approach**

The imaging modality in nontumor salivary gland disorders is based on the clinical features, which determine the differential diagnosis. Thus, the treating clinician should refer the patient for appropriate imaging to confirm or rule out a diagnosis. Imaging modalities for the diagnosis of salivary gland disorders include sonography, sialography (using either conventional radiography, CBCT, or magnetic resonance imaging [MR-sialography]), as well as multi-detector computed tomography (MDCT) and MRI. The last two modalities are usually used for suspected tumors of the salivary glands. Each modality demonstrates different aspects of the salivary glands. As mentioned above, choosing the appropriate imaging modality depends on the differential diagnosis and is beyond the scope of this review.

Sialography is a well-established tool which demonstrates the fine anatomy and morphometry of the salivary ductal system as well as its function. In the last decade, sialo-CBCT, has replaced traditional x-ray sialography, due to increased spatial resolution and accessibility as well as 3D representation, with a relatively low radiation dose.

MR-sialography is a diagnostic, noninvasive method for evaluation of nontumor salivary gland disease. This technique produces sialographic images without the need for an intraductal contrast medium by using the saliva as the fluid to demonstrate gland structure. MR-sialography has several advantages over sialo-CBCT: it does not use ionizing radiation; it can demonstrate all the major salivary glands simultaneously; it can detect premature fat deposition in the major salivary glands characteristic of SS; and it can be done in the presence of acute inflammation or when the duct orifice is blocked. The major disadvantages of MR-sialography examination compared to sialo-CBCT are: the long time it takes to perform the examination (30 to 40 minutes); the high cost; the lack of compliance in claustrophobic patients; the low availability and accessibility of machines; the poor anatomical details of the ductal system provided by the images, and the resulting difficulty in detecting small sialoliths.

Another technique is digital subtraction sialography, but this has several drawbacks, including the possible use of distorted projections that differ from the true anatomical dimensions, and that 2D image modalities have limited abilities to depict 3D structures.
The sialo-CBCT technique

Parotid or submandibular sialo-CBCT is done following a thorough clinical examination which includes extraoral examination to detect current swelling and intraoral examination to examine saliva secretion by milking the major salivary glands. Signs and symptoms of acute infection, including pus secretion during milking, fever, or glandular tenderness, are a temporary contraindication of sialo-CBCT. In these instances, the patient is prescribed antibiotics and the scan postponed for 1 week. If debris, such as a plaque, is found in the secretions, and there are no clinical signs or symptoms of infection, sialography may be performed. When there are signs of a tumor such as a unilateral palpable mass, facial palsy, or multiple palpable lymph nodes in the parotid or pre-auricular or neck areas, the patient should be referred to other imaging modalities, such as MDCT or MRI. In suspected obstructive cases, an “empty” scan using no-contrast low-dose CBCT is done before contrast administration, to detect hyperdense sialoliths.

The sialo-CBCT procedure begins with 2 minutes of mouth rinsing using chlorhexidine 0.2%. Then, the Stenson or Wharton duct is catheterized using lacrimal probes, followed by the intraductal introduction of 1 to 3 mL of aqueous iodine contrast medium (Iomeron 350, Bracco), using a 20G to 22G Anicath catheter (Fig 1). Thereafter, the relevant salivary gland region is scanned with a CBCT using the optimal scanning protocol. Scan parameters are tailored to gland and patient size. The effective dose in sialo-CBCT is variable and machine-dependent, and ranges between 60 and 160 μSv.25

Five minutes after catheter removal, a 2D image (“scout” view) is taken to record the clearance of the contrast medium and thereby evaluate gland function. In specific cases of incomplete emptying, another low-dose CBCT scan is performed to localize the obstructed region volumetrically.

Based on the present authors’ extensive experience over the last decade, patients seem to tolerate the procedure well, and report a mild sensation of “pressure” or “ballooning” of the gland region or tenderness of the orifice. No case of hypersensitivity has been experienced in the present authors’ center.26 In cases of insufficient clearance of the contrast medium or clinical swelling, antibiotics are prescribed to prevent secondary infection. The procedure usually takes 15 to 30 minutes.
Table 1  Basic definitions and proposed terminology for radiographic features of CBCT-sialography of major salivary glands

<table>
<thead>
<tr>
<th>Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stensen duct</td>
<td>Primary parotid duct</td>
</tr>
<tr>
<td>Wharton duct</td>
<td>Primary submandibular duct</td>
</tr>
<tr>
<td>Ducts of Rivinus or Bartholin duct</td>
<td>Primary sublingual duct</td>
</tr>
<tr>
<td>Proximal region</td>
<td>Closer to saliva-producing acini</td>
</tr>
<tr>
<td>Distal region</td>
<td>Closer to duct orifice</td>
</tr>
<tr>
<td>Normal structure</td>
<td>Primary duct of uniform thickness, fed by secondary, tertiary, quarterly, and quintile ducts, without sialectasis or other altered morphology</td>
</tr>
<tr>
<td>Duct stricture</td>
<td>Localized (≤ 1 mm) decrease in duct diameter</td>
</tr>
<tr>
<td>Duct stenosis</td>
<td>Continuous or segmental decrease (≥ 1 mm) in duct diameter</td>
</tr>
<tr>
<td>Duct dilatation</td>
<td>Segmental or total increase in duct diameter</td>
</tr>
<tr>
<td>Sialodochitis</td>
<td>Alternating dilatations and strictures of a duct</td>
</tr>
<tr>
<td>Megaduct</td>
<td>Abnormal dilatation of the duct with sausaging</td>
</tr>
<tr>
<td>Sialectasis</td>
<td>Spherical collections of different sizes of contrast medium in peripheral dilated acini</td>
</tr>
<tr>
<td>Ductopenia</td>
<td>Reduced maximal branching level</td>
</tr>
<tr>
<td>Extravasation</td>
<td>Leakage of contrast medium to the extra-ductal parenchyma</td>
</tr>
<tr>
<td>Atrophy</td>
<td>Decrease in salivary gland volume</td>
</tr>
</tbody>
</table>

Following volume reconstruction, an image of the gland of interest is obtained using a curved plane, following most of the glandular arborization (usually 10-mm thickness), as well as axial, coronal, and sagittal views, observed in maximal intensity projection (“MIP”) (usually 30-mm thickness) (Figs 2a to 2e). As required by international guidelines, the entire imaging volume is interpreted and all incidental findings are reported.27

**Limitations**

Minimal inject-to-scan time is important to avoid premature emptying (Fig 2f). Sialo-CBCT does not provide information about the parenchymal soft tissues around the acinar component of the gland. Furthermore, the sialo-CBCT technique is difficult and requires special training and operator experience, as well as excellent patient-operator communication to achieve adequate glandular filling. Sialo-CBCT complications include primary duct perforation, forced retrograde advancement of hypodense sialoliths, and secondary local infection.

**Interpretation**

Sialo-CBCT interpretation includes the description of the primary duct morphology; branching for secondary, tertiary, and descending branches; and the presence of sialectasis and possible space occupying lesions in the parenchyma. Lastly, 5 minutes after cannula removal, gland activity is evaluated by assessing iodine clearance in the post evacuation image.

Sialo-CBCT radiographic findings may be complex when secondary pathology is superimposed on the primary disorder. For example: SS patients may experience secondary obstructive sialadenitis due to longstanding hyposalivation, therefore the images may include sausaging consistent with obstructive sialadenitis as well as ductopenia and/or sialectasis (described below in the terminology section).27

Examinations are considered adequate when they include:

- a field of view (FOV) with the entire area of the primary duct and acinar components
- minimal or no motion artifacts
There is considerable confusion in the literature regarding the following definitions, and terms seem to be used interchangeably. Based on the present authors’ extensive experience, the following terminology is proposed (see Table 1 for a summary of the proposed terminology).

**Primary duct regions**

Proximal: closer to saliva-producing acini. Distal: opposite direction, close to duct orifice.

**Normal structure**

The three pairs of major salivary glands are the parotid (opening through Stensen duct), submandibular (opening through Wharton duct), and sublingual glands (opening through several ducts of Rivinus or Bartholin which then join Wharton duct). The anatomical architecture of all the glands is essentially the same: the acini, which are the secretory end pieces, produce saliva and an arborized ductal structure that opens into the oral cavity, via one tributary (Fig 2). The duct collecting saliva from the acini is the intercalated duct, which drains into striated ducts, and finally into excretory ducts. All ducts progressively increase in size and ultimately unite as the main excretory (primary) duct. An accessory parotid gland lying anteriorly over the masseter muscle between the parotid duct and the zygomatic bone may also be present.

**Pathology of the primary duct**

**Ductal stricture**

Localized (≤ 1 mm) decrease in duct diameter, compared to proximal and distal parts of the same duct (Fig 3a).

**Ductal stenosis**

Continuous or segmental decrease (≥ 1 mm) in duct diameter, compared to proximal and distal parts of the same duct (Figs 3b and 3c).
Ductal dilatation
Segmental increase in duct diameter, compared to proximal and distal parts of the same duct, or an increase in the diameter of the entire duct compared to typical dimensions (Fig 3a).

Sialodochitis
Segments of alternating duct dilatations and strictures, creating a “sausage-like-appearance” (Fig 3a). 31

Megaduct
Enormous, abnormal dilatation of the duct with sausage-string-type strictures (Fig 3d). 32

Sialectasis
Spherical collections of different sizes (punctate [< 1 mm], globular [1 to 2 mm], and cavitory [> 2 mm]) of the contrast agent in peripheral dilated acini, possibly caused by trapped contrast medium in narrow intercalated ducts, or due to lymphocytic infiltration (Fig 4). The iodine tends to remain in these areas for more than 5 minutes after de-cannulation (Fig 4d).

Ductopenia
Diminished arborization pattern, with a reduced maximal branching level. May be graded as severe (demonstration of only primary and secondary ducts), moderate (primary-secondary and tertiary ducts shown), or mild (decreased number of ducts compared to normal) (Fig 5). 17

Extravasation
Leakage of contrast medium from the ductal system into the extra-ductal parenchyma (Fig 5b). This may be caused by either excessive pressure during the manual filling of the gland or due to disruption or impairment of intercellular junctions between ductal cells. In some cases, this obscures glandular morphology, and prevents the establishment of a radiographic diagnosis.

Atrophy
Decreased salivary gland volume, compared to the homolog gland or to the expected anatomical size (Fig 6).
Key findings of common nontumor salivary gland disorders

A summary of clinical findings and radiographic features of common salivary gland disorders is provided in Table 2.

Sjögren syndrome (SS)

Clinical manifestations

SS is an autoimmune disease characterized by progressive destruction of exocrine (lacrimal and salivary) glands, leading to a significant reduction in the secretion of tears and saliva. SS is classified as primary or secondary depending on the coexistence of another connective tissue diseases, such as systemic lupus erythematosus or rheumatoid arthritis.

Suggested pathogenicity

Histopathologic examination of affected labial minor salivary glands, a common diagnostic technique for SS, reveals focal, periductal mononuclear cell infiltrates, and a loss of acinar cells with relative preservation of ductal cells. The focal lymphocytic infiltration is the hallmark histopathologic finding of SS. The infiltrate is T and B cells (80%: 20%), which produce a plethora of immunologically active products. Chronic inflammation with possible T cell-dependent antigen stimulation may induce neoplastic transformation of lymphocytes, increasing the risk of lymphoma development.

Sialographic features

Sialoatresia is considered the radiographic hallmark of sialo-CBCT sialadenitis in SS (Fig 4). Recently, the primary author suggested that ductopenia might also be a significant sialographic finding in SS (Fig 5). Ductopenia was found to be strongly associated with the number of secondary and tertiary ducts and moderately associated with the number of sialectasis, possibly due to a combination of parenchymal inflammatory infiltrates and fibrosis. Strong correlations were also found between: number and maximal size of sialectasis and number.
Table 2  Key findings of salivary gland disorders

<table>
<thead>
<tr>
<th>Salivary gland disorder</th>
<th>Clinical findings</th>
<th>Key sialo-CBCT radiographic features</th>
</tr>
</thead>
</table>
| Sjogren syndrome (SS)  | Combination of dry mouth, eyes and extraglandular manifestations, with or without non-mealtime recurrent or persistent swellings | • Sialectasis are pathognomonic  
• Other manifestations: ductopenia and extravasation  
• Primary duct may be thin unless secondarily infected (causing sialodochitis) |
| Recurrent juvenile parotitis | Non-mealtime recurrent swellings, children, uni- or bilateral, non-purulent, unknown etiology (possibly auto-inflammatory) | • Sialodochitis are pathognomonic  
• Other manifestations: ductopenia  
• Primary duct is usually thin. |
| Chronic obstructive sialadenitis | Recurrent mealtime swellings, etiology may be anatomical variations in ductal system or local obstruction (sialolith) | • Sialodochitis of primary and sometimes secondary and tertiary ducts  
• Filling defects (non-calcified sialolith) |
| Sialolithiasis | Recurrent mealtime swellings, usually unilateral, caused by non-calcified or calcified obstruction | • Perform “empty” CBCT scan  
• If negative- sialodochitis / possible filling defect (non-calcified sialolith) / stenosis |
| Radioactive iodine-induced damage | Recurrent non-mealtime swellings in a patient with history of thyroid carcinoma | • Sialodochitis  
• In late stages the gland might be atrophic |
| Space-occupying lesions | Detected incidentally. Often patient complains of swelling. | • Non-filling area  
• Duct splaying (“ball in hand”)  
• Duct deviation |

of secondary ducts, number of tertiary ducts and secondary/tertiary ratio. The radiographic features such as number and size of sialectasis, ductopenia, extravasation, and ductal diameter, correlated with clinical data, such as xerostomia and stimulated salivary flow rate.17

In the early stages of SS the primary ducts appear normal; in the later stages there may be evidence of secondary infection.31

**Recurrence juvenile parotitis (RJP)**

**Clinical manifestations**

RJP is a rare nonobstructive, nonsuppurative parotid inflammatory disease mostly occurring in children between the ages of 3 and 5 years, but may also be seen in young adults, with male predominance, classically resolving at adolescence.38,39 In some cases a family history is identified. The etiology is unknown but appears to be multifactorial, including modification of the composition of saliva, intraductal malformations, allergies, viral infections, and immune disorders, especially IgA deficiency.40 Interestingly, sialography,38 as well as sialo-endoscopy41 decrease the recurrent glandular swelling and therefore improve the clinical status of the patient.

**Suggested pathogenicity**

The pathogenicity is unknown but is suggested to be related to a modification of saliva inducing ascending superinfection that is followed by an infiltration of plasma cells destroying the gland parenchyma and causing the formation of sialectasis, which predispose recurrences.39-41 A common endoscopic finding is a white appearance of the ductal layer without the healthy blood vessels, suggestive of recurrent inflammation.41

**Sialographic features**

Sialography reveals ductopenia – mainly in primary and secondary ducts with numerous various sized sialectasis (Figs 4e and 4f).38,39 Sialectasis are seen in both the affected and contralateral glands.41 The primary duct usually appears homogeneously thin.41 Due to the young age of most patients, the sialography imaging modality of choice should be panoramic or scout image of the CBCT machine, to reduce the radiation dose.

**Chronic obstructive sialadenitis (COS)**

**Clinical manifestations**

COS is the most common type of chronic sialadenitis42 mainly affecting the submandibular gland, but the parotid may also be involved.34 Intra- and extraductal mechanical factors obstruct the salivary duct system which disrupts salivary secretion.3 Patients usually complain of recurrent mealtime swellings which resolve by massaging the affected area, with or without antibiotics. Milking may produce either pus or pulsed secretion of saliva.
Suggested pathogenicity
COS is histologically characterized by a periductal lymphocytic infiltrate and acinar atrophy. The persistence and progression of secretory congestion may be associated with accentuated periductal and intralobular fibrosis, destruction of the lobular architecture, parenchymal loss, and sclerosis, with functional loss of the gland. The exact etiopathology and mechanism of atrophy of the glandular cells and lymphocytic infiltration associated with an increase in extracellular matrix in COS are unknown.

Sialographic features
The primary duct may show a combination of strictures and dilatation, in the form of sialodochitis, ie a sausage-like appearance (Fig 3a). Sometimes it may also resemble “beads-on a string,” where there is overall stenosis of the primary duct, which is inflated by the contrast medium in a delicate manner (Figs 3b and 3c). In longer-term cases the secondary and tertiary ducts may also be affected (Fig 3a). Occasionally, sialodochitis may also be demonstrated, secondary to the above-mentioned features, in a manner similar to SS’s affected glands with secondary COS (where a clinical-radiologic correlation is needed). COS is strongly associated with sialolithiasis (see below).

Sialolithiasis
Clinical manifestations
Sialolithiasis is the most common cause of COS. More than 90% of sialoliths form in the submandibular gland. Symptoms are similar to COS, but some patients may report feeling a “stone” in the area corresponding to the glandular duct.

Suggested pathogenicity
The exact cause of salivary calculus formation is unknown. Disturbed salivary secretion and a change in the composition of saliva, termed “dyschylia,” leads to an increase in salivary viscosity and to a mucous obstruction in the terminal ducts. Normal glands may contain microliths that cause local obstruction and the atrophic foci become reservoirs for ascending infection. Ductal secretory congestion is associated with the proliferation of ascending bacteria, which may play a major role in the formation of sialoliths in the presence of microliths. Sialolith formation may lead to other atrophic changes in the ductal system due to chronic inflammation, and secretory inactivity of the acini.

Sialographic features
A hyperdense structure (sialolith) may be detected in an “empty” non-contrast CBCT scan (Figs 7a and 7b). In cases of

Figs 7a to 7d  Sialoliths and filling defects. (a) Hyperdense sialolith in the left submandibular gland in sagittal, non-contrast CBCT scan. (b to d) CBCT sialography images. (b) Hypodense sialolith surrounded by iodine (arrows) following intraductal iodine insertion to the submandibular gland. (c) Hypodense area suggestive of hypodense sialolith in submandibular gland. (d) Filling defect in primary parotid duct suggestive of air bubbles or hypodense sialolith, right parotid gland (gland images, shown in MIP).
noncalcified obstructions, a filling defect may be visible on sialo-CBCT with subsequent duct dilatation, proximal to the filling defect, corresponding to the location of the noncalcified sialolith (Fig 7c). Furthermore, sialographic features of COS may also be present. Air bubbles may be confused with noncalcified filling defects and therefore a clinical-radiographic correlation is necessary (Fig 7d).

**Iodine-induced sialadenitis**

**Clinical manifestations**

Radioactive iodine ($^{131}$I) is used for ablation of the remnant of thyroid carcinoma. During treatment, the iodine also accumulates in the salivary glands leading to frequent swellings and decreased salivary flow. Approximately 24% of the administered $^{131}$I dose is secreted in saliva, and the host inflammatory response to radiation damage causes constriction of salivary ducts with salivary retention and symptoms of obstruction.

Acute sialadenitis often resolves within days, but loss of fluid producing acinar cells and inflammatory scarring of salivary ducts often lead to recurrent exacerbations that cause chronic sialadenitis and xerostomia.

Salivary gland damage is dose related, beginning with a cumulative dose of $>150$ mCi (5.55 GBq).

**Suggested pathogenicity**

The sodium/iodine symporter on follicular thyroid cells is also found on the basolateral membranes of striated duct cells of salivary glands and causes the radiiodine accumulation in ductal cells. However, similar to active uptake of $^{99m}$Tc-pertechnetate by ATP-dependent Na$^+$/K$^+$/Cl$^-$ -cotransport system, substitution of chloride results in $^{131}$I accumulation in the acinar cells of the salivary glands. Based on alterations in quantitative scintigraphy, a number of studies have suggested parenchymal damage as an underlying reason for salivary dysfunction.

**Sialographic features**

Findings are similar to COS with sialolith. In later stages the gland may be atrophic (Fig 6).

**Graft-versus-host disease (GVHD)**

**Clinical manifestations**

GVHD is a major complication of allogeneic stem cell transplantation. The clinical and pathologic features resemble a combination of several collagen vascular diseases and immune dysregulation. GVHD-related dysfunction of the major salivary glands often leads to hyposalivation and xerostomia; with a decrease of 60% in whole saliva flow compared to healthy individuals and a subjective score of 2.1 in a scale from 0 to 4 (where higher scores indicate greater oral dryness) reported.

In addition, the altered saliva composition may diminish its quality, ie a greater mucoid fraction with less fluidity. It is important to note that the salivary glands in these patients may also have been damaged by the pretransplant conditioning regimens, which often include chemotherapy and total body irradiation.

**Suggested pathogenicity**

Salivary gland involvement is characterized by lymphocyte (mostly T-lymphocyte, CD8+ predominance over CD4+) infiltration into the glandular parenchyma particularly around the secretory ducts. Ductal epithelial cell-associated lymphocytic
Space-occupying lesions (SOLs)

Clinical manifestations
SOLs of the salivary glands are rare and can be subdivided into cystic conditions and neoplastic lesions. Fewer than 5% of salivary gland masses are cystic, and salivary gland tumors represent less than 3% of all tumors in the head and neck region. Due to the embryonically diverse tissues of origin of salivary glands, neoplastic SOLs can be adenomas, carcinomas, mesenchymal tumors, lymphomas, and metastasis. Enlarged and calcified lymph nodes may be seen within the glands. In patients with SS, mucosa-associated lymphoid tissue (MALT) lymphoma should be considered. Tumors are most often found in the parotid, followed by the submandibular and the sublingual glands. Clinical manifestations usually include a persistent lump, facial nerve palsy, infiltration of overlying skin, and local lymphadenopathy.

The etiology of tumor infiltration is unclear. Suggested factors include a history of a benign tumor (such as a pleomorphic adenoma) in childhood and previous localized radiation. Chronic inflammation has not been defined as a possible etiologic factor.

Differentiating benign and malignant tumors based on imaging is challenging and is therefore confirmed by the clinical and histopathologic findings. Recently, the authors of this paper found that clinical and radiographic features were similar in benign and malignant SOLs detected using sialo-CBCT (unpublished results).

It should be noted that sialography is not the imaging method of choice in clinically suspected masses, but SOLs may be encountered incidentally in sialo-CBCT and thus should be kept in mind, during the vigilant reviewing of the entire glandular sialo-CBCT scan volume.

Sialographic features
Radiographic findings of SOL may include an area of no filling (Figs 9a and 9b), splaying of ducts with a “ball-in-hand” appearance, and a localized deviation of a primary duct. In these cases, filling adequacy should be confirmed. In some cases, the sternocleidomastoid muscle can impinge on the salivary ductal system, causing duct splaying (Fig 9c), and this should not be misdiagnosed as an SOL. Clinical correlation is needed as well as other imaging modalities, such as MRI or ultrasound-guided fine needle aspiration or biopsy.

Conclusions
Sialo-CBCT uses iodine to examine glandular ductal morphology and function, and aids in diagnosis and management of
nontumor salivary gland disorders. The technique is relatively sensitive, requiring operator experience. The sialographic features of SS and RJP include sialectasis and ductopenia. In COS and salolithiasis, sialodochitis with or without filling defects are noted. In radioactive iodine-induced damage, findings are similar to obstructive sialadenitis, with atrophy in advanced stages. In GVHD, structural changes include ductopenia and to a lesser extent, sialectasis and sialodochitis. If an area of no-filling, spalying of ducts, and primary duct deviation is seen, the clinician should consider the possibility of a SOL.

**Disclosure**

No financial supported has been granted for this research project. The authors have no conflicts of interest to declare.

---

**References**


Ragda Abdalla-Aslan

Attending Oral Medicine Specialist and Head of Oral and Maxillofacial Imaging, Department of Oral and Maxillofacial Surgery, Rambam Health Care Campus, Haifa, Israel; and Oral Medicine Specialist, Oral Medicine and Sedation and Imaging, Hebrew University-Hadassah School of Dental Medicine, Jerusalem, Israel

Correspondence: Dr Chen Nadler, Oral Maxillofacial Imaging Unit, Department of Oral Medicine, Hadassah School of Dental Medicine, 91120, Jerusalem, Israel. Email: Nadler@hadassah.org.il