Chapter 58: Diagnostic Imaging

Dale H. Rice

A variety of diagnostic imaging techniques is available for the investigation of salivary gland disorders. For practical purposes these techniques are of use only for the parotid and submandibular glands. Although sialography of the sublingual glands can be done, it is of little practical value. The techniques in current use are sialography, radionucleotide scanning, ultrasonography, computed tomography (CT) scanning, and magnetic resonance imaging (MRI).

Sialography

Sialography is currently used to evaluate calculi, obstructive disease, inflammatory lesions, penetrating trauma, and mass lesions.

Mercury was used in 1904 for the first sialogram reported (Carpy and Poirer, 1904). Both water-soluble and oil-soluble contrast media have been used, with water-soluble media currently preferred (Table 58-1). Correct interpretation of the sialogram requires a thorough knowledge of the anatomy of the parotid and submandibular glands. Since Chapter 56 discusses this anatomy, it is not repeated here except for particular points important to the study under discussion.

To perform a sialogram, the following equipment should be available: water-soluble contrast media, such as meglumine diatrizoate 76%, a good light source, a topical anesthetic for the duct orifice, lacrimal dilators, a lacrimal cannula, a syringe, polyethylene tubing, a Rabinov cannula, and a tapered sidehole needle.

First, the ostium is anesthetized. If the precise opening cannot be readily identified, the area should be dried, the gland gently massaged, and the area observed for the flow of saliva. If the duct cannot be easily cannulated, gentle dilatation can be performed with lacrimal dilators.

Contrast medium is injected gently until the patient experiences pain. For each gland (parotid or submandibular) anteroposterior, lateral, and oblique roentgenograms are obtained to eliminate all bony overlapping. A separate injection is done for each exposure to ensure adequate filling of the ductal systems and a good parenchymal phase.

Bilateral studies may be advisable to detect subclinical disease in the contralateral gland. Also, deviations from normal can be better appreciated. Furthermore, displacement of the gland by an extrinsic mass can more readily be seen. Finally, if the diseased side is studied first, radiographs of the contralateral side can serve as drainage views of the diseased side (Valvassori et al, 1982).

In the lateral view the area of the parotid gland varies from 10.1 to 21.2 cm^2 with a variation right to left of 2.5 cm^2 (Ericson, 1973). Stensen's duct ranges from 0.8 to 3.2 mm in diameter, with a right-left difference of up to 0.7 mm. The parotid duct is approximately 6 cm long with second- and third-order branching. In the anteroposterior view the duct is approximately 2 cm lateral to the mandible. Accessory lobules are occasionally seen superior to the duct. The submandibular duct is 5 cm long and 2 to 4 mm wide, with branching similar to the parotid. Acinar filling may or may not occur, depending on the pressure of injection, the contrast medium, and the condition of the gland. Retention of water-soluble contrast medium beyond 5 minutes has been established as the norm for secretory ability. In general, if contrast medium is retained, the abnormalities provide the diagnosis.

The most important contraindications to sialography are iodine allergy and acute sialadenitis. If thyroid function tests are to be performed and if iodine interferes with them, they should be completed first.

Several variations in technique have been introduced over the years to improve the capability for diagnosing various lesions. These include simultaneous xeroradiography (Ferguson et al, 1976), the use of pneumography with tomography (Granone and Julian, 1968), secretory sialography (Rubin and Blatt, 1955), and CT sialography (Mancuso et al, 1979). Only secretory sialography is of contemporary interest. It allows a measure of the physiologic function of the gland. CT sialography is excellent for the evaluation of mass lesions, but is unnecessary with contemporary scanners.

Radiopaque calculi can usually be seen on the preliminary radiographs (Fig. 58-1). Twenty percent of submandibular calculi and 80% of parotid calculi are radiolucent. Eighty to 90% of all calculi occur in the submandibular gland. Multiple calculi occur in up to 25% of patients who develop calculi (Suzuki and Kawashima, 1969). Calculi rarely cause complete obstruction, so contrast medium flows around them, showing a filling defect on sialography. A dilation of the main duct (if the calculus is distal) or of the intraglandular ducts may exist (if the calculus is in the hilum) (O'Hara, 1973). Occasionally a calculus passes but symptoms persist. This may indicate a ductal stricture that can be demonstrated with sialography. After passage or removal of the calculus, the sialographic appearance of the gland may resemble chronic sialadenitis.

The changes seen in inflammatory diseases depend on the severity and chronicity of the process. These chronic inflammatory lesions are believed to represent a spectrum of diseases from chronic sialadenitis through the benign lymphoepithelial lesion to Sjögren's syndrome. These lesions all involve a lymphoreticular infiltrate combined with acinar atrophy and ductal metaplasia ending in the epimyoepithelial island (Batsakis et al, 1975). The histologic picture is similar, with variations being related only to distribution and severity.

The primary pathogenic event in chronic sialadenitis is believed to be a decreased secretion rate with subsequent stasis. Two theories of initiation are currently espoused. One is that repeated acute episodes or a single severe episode of acute suppurative sialadenitis leads to ductal metaplasia of mucus-secreting glands. This situation leads to an increased mucus content in the saliva, causing stasis. The other is that if the gland is colonized by pyogenic bacteria, an acute suppurative infection occurs, whereas colonization with opportunistic flora leads to chronic, recurrent sialadenitis. This disease is much more common in the parotid gland, presumably because of its longer, narrower duct, making it more susceptible to stasis (Rausch, 1974). Repeated episodes lead to sialectasis, ductal ectasia, and progressive acinar destruction combined with a lymphocytic infiltrate.

As already implied, the sialographic appearance parallels the degree of histologic change, and all chronic inflammatory lesions give similar sialographic changes. The changes that may be seen include saccular dilatation of the terminal ducts and acini, segmental strictures and dilation, and pseudocyst formation. Four stages of sialectasis have been described: punctate, globular, cavitary, and destructive. Som et al (1981) reported that the punctate and globular forms may actually represent extravasation of contrast media through damaged ducts.

The benign lymphoepithelial lesion gives a similar sialographic appearance. In fact, some regard this lesion as "end-stage" chronic recurrent parotitis (Batsakis and Sylvest, 1977). Similarly, varying degrees o pseudosialectasis characterize the sialographic appearance of either primary or secondary Sjögren's syndrome (Figs. 58-2 to 58-4).

Sialography may be of value in assessing penetrating trauma, especially involving the parotid gland. It may demonstrate occlusion of a duct, a salivary-cutaneous or salivary-oral fistula, or a sialocele (Fig. 58-5). Displacement of the gland by edema or hematoma can also be demonstrated.

Sialography has long been used to evaluate mass lesions. Information can be obtained concerning the size and location of the mass, whether it is intrinsic or extrinsic (Fig. 58-6), and whether it is benign or malignant. Depending on the extent of the lesion and its location, this information can be of variable accuracy. Tumors 1 cm or less are difficult to demonstrate, especially if peripherally located. Masses greater than 1 cm can usually be easily located by their disturbance of the ductal architecture (Valvassori et al, 1982). The mass may drape around or displace the ducts. For benign tumors the margins should be smooth, with no evidence of extravasation of contrast material (Figs. 58-7 and 58-8). Several sialographic changes are characteristic of malignant tumors. These are (1) destruction of ducts, (2) irregular borders, (3) encasement of major ducts, and (4) cystic cavities that fill with contrast media.

In the deep lobe the ducts normally can be seen passing around the mandible below the condyle. They are parallel and oblique and course superiorly from lateral to medial. A deep-lobe tumor disrupts this and is best seen on the anteroposterior projection.

In one study assessing the accuracy of sialography, 5 of 7 malignant parotid tumors were correctly called. However, 6 of 30 benign tumors were called malignant (Calcaterra et al, 1977).

In summary, sialography is currently best for studying the ductal system. No other test supplies useful information about ductal architecture and glandular patterns. On the other hand, sialography has little to offer in the study of mass lesions. The information obtained is severely restricted if the mass is small or extrinsic to the gland.

Radiosialography

Salivary glands can also be studied by radioactive scanning. This technique has been most used for the parotid gland. The most popular substance used is technetium. Technetium is an artificially produced element obtained by molybdenum decay (first produced in 1933).

The atomic number is 43, and the atomic weight is 99. The half-life of the most stable form is 215.000 years, but in the medical form it is 6 hours. The tetraoxygenated form (pertechnetate) is distributed in body fluids as is iodide, except iodine is not absorbed in the thyroid. It has no beta irradiation, but emits gamma irradiation at 140 keV energy level.

Radioisotope scanning is used to evaluate parenchymal function and to detect mass lesions. It is of use in studying the ductal system. Sequential scanning demonstrates uptake of pertechnetate from the vascular system and its subsequent secretion in saliva (Greyson and Noyak, 1978). In a normal study, uptake in the parotid occurs before uptake in the submandibular gland, and the glands are symmetric. Although uptake occurs in the sublingual and minor glands, this study has little to offer in investigating them. The scan should be performed in the resting state because uptake in the parotid is greater (Stephens et al, 1976).

Radioisotope scanning was first used to study masses in the parotid. In one study of 106 patients, scanning had a 78% accuracy rate; 22% were incorrect, and all were false-negatives (Gates, 1972). Warthin's tumor and the rare oncocytoma are radiopositive, but all others are generally radionegative. One case of a radiopositive pleomorphic adenoma has been reported (Hendra and Stebner, 1975).

The first report of sequential scanning for the assessment of physiologic function was in 1971 (Schall et al, 1971). In generalized parenchymal disease, such as postradiation or chronic sialadenitis, the abnormality is evident on sequential scanning by the decreased and delayed uptake.

At this time, radioisotope studies have little to offer in the evaluation of salivary gland disease (Eneroth and Ling, 1976). Sialography provides more information about the ductal system (Schmitt et al, 1976), and CT scanning and MRI are superior in the evaluation of mass lesions.

Ultrasonography

Bozin et al (1971) first reported the use of ultrasonography to study the salivary glands. Ultrasound is generally able to distinguish intrinsic from extrinsic masses (Gooding, 1980). One study with histologic follow-up showed that malignant tumors have a low reflectivity with poorly defined borders, whereas pleomorphic adenomas have a variable reflectivity with well-defined borders (Baker and Ossoinig, 1977). Inflammatory lesions have high reflectivity with diffuse borders.

Ultrasonic imaging has also been used to direct needle aspiration of parotid abscesses (Magaram and Gooding, 1981); it is quite effective at this. It has also been used to localize calculi (Pickrell et al, 1978).

Like radioisotope scanning and sialography, ultrasonography has been largely supplanted by CT scanning for the evaluation of masses. It is, however, effective in guiding needle aspiration of parotid abscesses and may obviate the need for incision and drainage (Figs. 58-9 and 58-10).

Computed Tomography

CT scanning is the study of choice for intrinsic and extrinsic parotid masses. It is of little use in evaluating generalized parenchymal disease or ductal architecture. CT scans can be made with or without simultaneous sialography and with or without intravenous contrast enhancement.

CT sialography is excellent for differentiating intrinsic from extrinsic masses (Figs. 58-11 and 58-12), for differentiating benign from malignant masses, for showing the relationship of the mass to the facial nerve, and for differentiating superficial from deep-lobe tumors (Rice et al, 1980). It is also particularly useful in separating parapharyngeal masses from deep-lobe parotid tumors (Som and Biller, 1979). In my experience it has been highly accurate in differentiating benign from malignant parotid neoplasms, and others have confirmed this rate of accuracy (Som and Biller, 1980). Malignant tumors tend to show irregular outlines, diffuse borders, and nodal metastases.

With the newer generations of CT scanners, equally good results can be obtained using intravenous contrast enhancement rather than sialography. Although CT scans are no substitute for a histologic diagnosis, the general appearance of the mass often gives considerable insight into its histologic type.

The pleomorphic adenoma usually has crisp borders, unless it has become large enough to be lobulated (Figs. 58-13 and 58-14). Similarly, Warthin's tumor is sharply circumscribed.

Malignant neoplasms are often irregular and infiltrative. The low-grade mucoepidermoid carcinoma, when small, is similar in appearance to the pleomorphic adenoma. Larger lesions become lobulated with less regular borders. High-grade mucoepidermoid carcinomas are infiltrative and destructive. Other malignancies are similar to the high-grade mucoepidermoid carcinoma with irregular margins and a density greater than that of normal parotid tissue (Figs. 58-15 and 58-16). All are enhanced by intravenous contrast.

Computed tomography is accurate in evaluating deep-lobe and parapharyngeal space lesions (Mancuso and Hanafee, 1982). There is a low-density fat plane between the parotid and pharyngeal constrictors that is displaced medially by deep-lobe parotid tumors or laterally by benign parapharyngeal lesions. Deep-lobe tumors may displace the carotid artery medially. Schwannomas and paragangliomas cause a loss of the low-density area around the carotid artery and may displace the jugular vein, whereas malignant lesions destroy fascial planes.

CT scanning with intravenous contrast enhancement is currently the study of choice for evaluating parotid masses or parapharyngeal masses.

Magnetic Resonance Imaging

MRI, which has improved markedly in the past few years, is excellent at separating adjacent soft tissues. It has a further advantage in being able to provide simultaneous coronal, axial, and sagittal views.

Two recent advances have added to its value. The first was the introduction of gadolinium, a paramagnetic compound that enhances vascular lesions. The second was the development of MRI angiography. A general disadvantage of MRI is that it does not show bone. Thus CT and MRI are often used in a complementary fashion when evaluating lesions in and around bone.

For salivary gland tumors, gadolinium-enhanced MRI is equal or superior to contrast-enhanced CT (Fig. 58-17).