Ultrasound of the salivary glands

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High resolution ultrasound is considered the first line imaging investigation in the management of a salivary gland swelling. This article describes the normal anatomy of the salivary glands and outlines the typical ultrasound appearance of some of the common and serious diseases affecting them.

Normal anatomy of the salivary glands

The parotid gland

The parotid gland is the largest salivary gland, measuring on average 46mm in the vertical dimension by 37mm in the horizontal dimension. It lies below the zygomatic arch, between the posterior ramus of the mandible anteriorly and the mastoid process and the sternocleidomastoid muscle posteriorly. The gland extends a short distance over the superficial aspect of the masseter muscle (figure 1). The gland is homogenous with a similar echogenicity to the thyroid gland. In older patients the gland is often more hyperechoic due to the increase in fat deposition within the gland. The gland and capsule contain lymph nodes. The main intraglandular duct may be seen as two parallel hyperechoic lines within the gland. The main extraglandular duct is not often seen unless dilated, but passes over the superficial surface of the masseter muscle, curving around the anterior border of the muscle before piercing the buccinator muscle. It opens into the oral cavity at the parotid papilla, located opposite the upper second molar tooth. The duct passes about 1cm below the zygomatic arch and it can be palpated clinically if the patient clenches their teeth together. In 20% of patients there is also an accessory parotid gland which is normally found overlying the masseter muscle just superior to the duct.2

The superficial and deep lobes of the gland are separated from each other by the retromandibular vein which can be identified on ultrasound. The facial nerve is not identified on ultrasound but passes superficial to the retromandibular vein. The gland should be scanned in both the longitudinal and transverse planes and the probe angled forward behind the ramus of the mandible to ensure as much of the deep lobe is visualised as possible.

The submandibular gland

The submandibular gland on average measures 35mm (AP dimension) x 33mm (frontal dimension) x 14mm (paradimensional dimension), and is located in the submandibular triangle deep to the platysma muscle. The gland is divided into a large superficial part and a small deep part by the mylohyoid muscle which indents the anterior surface of the gland. The other muscles in close relationship to the gland are the anterior and posterior bellies of the digastric muscle, and the hyoglossus muscle (figure 2). The gland is hyperechoic in comparison to the adjacent muscles and is generally more hypoechoic than the parotid gland. Unlike the parotid gland no lymph nodes are found within the gland. The normal submandibular duct can sometimes be identified passing between the mylohyoid muscle and the hyoglossus muscle before passing between the sublingual gland and the genioglossus muscle. The lingual vein, which passes close to the duct, can be differentiated from the duct using colour Doppler. The ostium of the duct is located on the sublingual papilla. When scanning the gland the tortuous facial artery can be easily identified and followed on the deep surface of the gland before it emerges at the lower border of the mandible to supply the face.

The sublingual gland

The sublingual gland is the smallest of the major salivary glands. It lies deep to the mylohyoid muscle and is covered by the oral mucosa of the floor of the mouth. In the transverse plane the gland is oval in shape. In some patients the gland may herniate through the mylohyoid muscle.3 The submandibular duct is located medial to the gland. The gland normally drains into the mouth through multiple small excretory ducts or sometimes it may drain directly into the submandibular duct. These smaller ducts are not visible on ultrasound.

Diseases of the salivary glands

Obstruction

A calculus or salivary stone is shown on ultrasound as a hyperechoic focus casting an acoustic shadow. Generally only calculi greater than 2mm in diameter can be demonstrated.4 Small calculi may not always cast an acoustic shadow. In the submandibular system, most calculi are found in the distal third of the main extra-glandular duct, with only about a third located within the gland or hilum.5 Calculi in the distal duct can be difficult to see due to acoustic shadowing from the mandible, but using a curvilinear array probe may help in these cases. An example of a submandibular gland calculus is shown in figure 3. Parotid calculi are less common but show the same sonographic features.

The use of a sialogogue may make it easier to detect smaller sialoliths. A sialogogue may also demonstrate mobility of the calculus which can influence management as mobile stones can be retrieved using a dormia basket.

Duct stenosis or stricture account for around 25% of salivary obstruction cases.6 Most strictures are seen within the parotid duct. Stenosis can be implied if a dilated duct tapers forward to a point where the duct can no longer be seen.7 In cases of salivary obstruction there may also be sialadenitis present.

Inflammatory disease

Acute sialadenitis may be viral or bacterial in origin. On ultrasound the glands are enlarged heterogeneous and hypoechoic. The affected gland is hypervascular and there may be an associated lymphadenopathy. In chronic sialadenitis the gland is also heterogeneous and hypoechoic, and the gland may become atrophic.

In a child with recurrent pain and swelling of the parotid glands, juvenile recurrent parotitis should be suspected.
Salivary tumours

Benign tumours

Salivary tumours are rare, with only 1% of all tumours arising in the salivary glands. Eighty per cent of tumours are found in the parotid gland and 80% are benign.

The most common salivary gland tumour is the pleomorphic adenoma. These are most often located in the superficial lobe of the parotid gland. Typically these tumours are well defined, hypoechoic and lobulated and show acoustic enhancement. They are moderately vascularised on Doppler. An example of a pleomorphic adenoma is shown in figure 5.

Warthin's tumour is the second most common parotid tumour. On ultrasound they commonly present as a well-defined oval mass often containing hypoechoic (cystic) areas in the lower part of the parotid gland. About 12% of patients develop multiple Warthin's tumours either within the same gland or in the contralateral parotid gland, so it is important that all the salivary glands are fully examined.

Malignant tumours

Mucoepidermoid carcinoma is the most common malignancy affecting the salivary glands, accounting for about one-third of salivary malignancies. It is the most common malignancy in the parotid gland. Low grade mucoepidermoid tumours have a similar appearance to pleomorphic adenomas. A high grade malignancy typically presents as an ill-defined hypoechoic heterogeneous mass with high vascularity (figure 6). Adenoid cystic carcinoma is the second most common salivary gland malignancy and is the most common malignancy in both the submandibular and sublingual glands. It shows similar US features to mucoepidermoid carcinoma. Perineural spread is common but this cannot be detected on US.

If the full extent of the tumour cannot be fully visualised on US, then CT or MRI will be necessary. An example of when CT/MRI would be required is when the mass is within or extending into the deep lobe of the parotid gland.

Differentiating benign and malignant tumours on ultrasound

Generally, the smaller the salivary gland the tumour is located in, the more likely it is that the tumour is malignant. High grade malignancies have irregular ill-defined margins and an heterogeneous echotexture. There may also be lymph node involvement. Unfortunately it is often difficult to distinguish benign tumours from low grade malignancies as both have very similar features on ultrasound. Malignant tumours, though, tend to have a higher vascularisation with a scattered distribution of vessels. What is clear, however, is that there is a significant overlap between the US features of benign and malignant disease so fine needle aspiration cytology is recommended in all cases.

Summary

Ultrasound provides useful diagnostic information in patients with salivary gland disease and should be considered the first line imaging investigation.

References

Figure 1
Transverse scan of the right parotid gland. Posterior belly of the digastric muscle (large white arrow); masseter muscle (large black arrow); mandible (small black arrows); sternomastoid muscle (small white arrows).

Figure 2
Transverse ultrasound scan of the right submandibular gland. Anterior belly of the digastric muscle (large white arrow); mylohyoid muscle (large black arrow); hyoglossus muscle (small black arrows); posterior belly of the digastric muscle (small white arrow).

Figure 3
An example of a calculus in the left submandibular gland. Calculus (small black arrow); acoustic shadow (small white arrows); mylohyoid muscle (large white arrow).

Figure 4
Transverse scan of the right parotid gland showing the typical features of Sjögren’s syndrome.
Figure 5
Transverse scan of the right parotid gland showing a well-defined slightly lobulated mass demonstrating acoustic enhancement, features typical of a pleomorphic adenoma.

Figure 6
Transverse scan of the right parotid gland showing an irregular hypoechoic mass, features typical of a high grade malignancy.