

High Resolution Ultrasound of the Submandibular Gland

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ABSTRACT

Submandibular gland, the second largest salivary gland is commonly affected by various disorders. They range from sialolithiasis, sialoadenitis, and systemic conditions to focal benign or malignant lesions. Being superficial, the gland is very well evaluated by high frequency ultrasound. The disease characterization is possible in large number of cases. The ease in guidance for fine needle aspiration or biopsy has made ultrasound a preferred imaging modality in evaluation of submandibular gland diseases.

The common pathologies and their ultrasound appearances are discussed in this article.

Keywords: High frequency ultrasound, Neck ultrasound, Salivary gland ultrasound

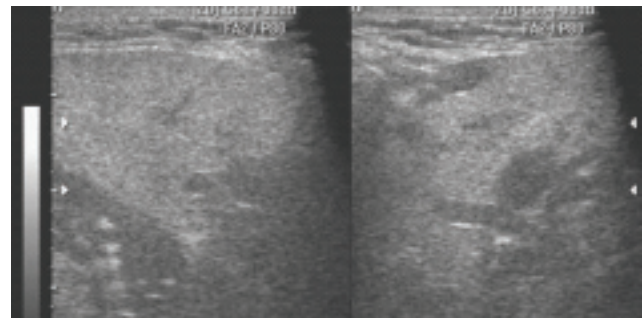
INTRODUCTION

Submandibular gland diseases are preferentially evaluated by high resolution ultrasound in last couple of decades. This simple non-invasive investigation helps in identifying and characterizing the lesion. It is a useful adjunct to the clinical examination [1]. The intra-glandular anatomy, pathology and its extent can be very well documented by high resolution ultrasound. Disorders like sialolithiasis, sialoadenitis, and diffuse as well as focal lesions are well identified. Another important role of ultrasound is to guide for fine needle aspiration or biopsy from the gland.

Normal Anatomy

Submandibular gland is the second largest amongst salivary glands and is located in the submandibular triangle. The gland is situated in the submandibular triangle whose superior boundary is formed by the inferior edge of the mandible and inferior boundary is formed by the anterior and posterior bellies of the digastric muscle. The superficial lobe of the gland is larger and deep lobe is smaller. Both are connected around posterior border of the mylohyoid muscle. The surgical treatment of the lesion remains same irrespective of its location in the either of the lobe [Table/Fig-1].

Wharton's duct may or may not be visualized in normal individuals on ultrasound. It arises from the hilum of the gland and traverse medially around the posterior belly of mylohyoid, medial to sublingual gland upto the papilla in floor of the mouth. The normal submandibular gland does not show intraglandular lymph node like parotid gland. Kuttner



[Table/Fig-1]: Normal submandibular gland showing homogeneous hypoechoic echotexture.

lymph node is situated posterior to the submandibular gland, adjacent to the parotid gland. The Kuttner lymph node should be considered abnormal in submandibular gland pathology [1].

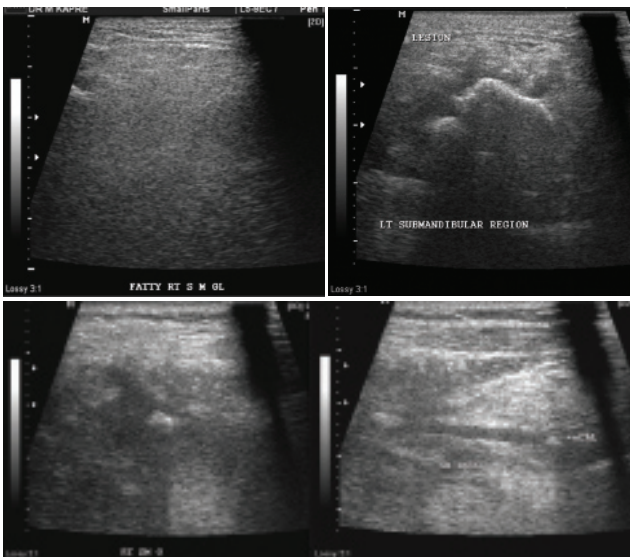
Echotexture of the submandibular gland is homogeneous, slightly hyperechoic in comparison to adjacent muscles. The echotexture of the gland depends on the amount of intra glandular fatty tissue.

Fatty Infiltration

The gland shows diffuse, usually bilateral and homogeneous enlargement with increased echogenicity on ultrasound due to fatty infiltration. It can make ultrasound assessment of deeper parts of the gland difficult due to beam attenuation [Table/Fig-2].

Sialolithiasis

Due to mucinous content of the secretions, calculi are most



[Table/Fig-2]: Submandibular gland showing generalized increased echotexture due to fatty infiltration. **[Table/Fig-3]:** Sialolithiasis large calculus in the gland. **[Table/Fig-4]:** Sialolithiasis image showing hyperechoic calculus in the glands with acoustic shadowing duct was also dilated showing calculus in it. (Images clockwise)

frequently found in the submandibular gland. Most of them (90%) are radiopaque. They occur in multiples in about 25% of cases. Ultrasound has a high degree of accuracy (96%) in diagnosis of calculus disease [2].

The calculi in Wharton's duct may cause obstruction mainly at the tortuosity around mylohyoid muscle which results in ductal dilation [3]. Dilated duct is very well visualized on ultrasound. Small calculi especially at the ostium are difficult to visualize on ultrasound but presence of ductal dilation should arouse suspicion [Table/Fig-3,4].

Complications of sialolithiasis like sialoadenitis, abscess and atrophy of gland (in cases of longstanding obstruction by calculi) are well evaluated by high frequency ultrasound.

Sialoadenitis

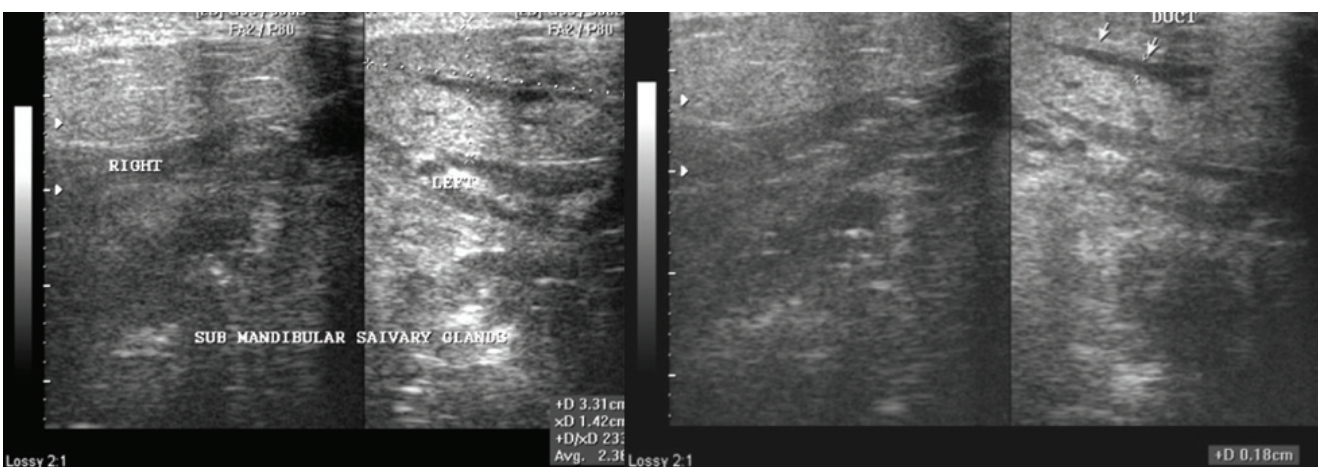
Acute Sialoadenitis: The infections are usually viral (most commonly mumps) and do not require ultrasound generally. However, bacterial infections occur due to retrograde passage of bacteria mainly in the elderly/debilitated persons, in postoperative patients. Also seen in dehydration, trauma, irradiation, and obstruction due to stones, tumours and strictures [3]. The most common causative organisms are *Staphylococcus aureus* or *Streptococcus viridians*. The gland appears enlarged and shows uniform hypoechoic echotexture on high frequency ultrasound [Table/Fig-5] [4]. In severe cases abscess formation occurs and is seen as ill-defined hypoechoic foci, with intraglandular ducts passing through the lesion. This is in contrast to ductal displacement usually seen in tumours.

Adjacent regional lymph nodes enlargement may be seen [Table/Fig-6]. Ultrasound is also used to guide drainage of suspected abscess.

Primary tuberculosis as a result of haematogeneous route spread may involve the submandibular gland. The presentation can be of acute sialoadenitis or sub-acute presentation like tumour [3]. Overall the imaging features are non-specific.

Chronic Sialoadenitis (Infective): Chronic obstruction due to sialolithiasis usually leads to chronic sialoadenitis. The gland size reduces due to recurrent infections, the margins become irregular. This appearance has been compared with liver margin appearance in liver cirrhosis [Table/Fig-7] [5]. On high frequency ultrasound the gland appears smaller and diffusely hypoechoic in echotexture. The chronic sialoadenitis can occur secondary to dental sepsis or duct stricture also.

Chronic Sclerosing Sialoadenitis: This condition is also known as Küttner tumour. There is a focal lesion from chronic inflammation of the submandibular gland. This is generally caused by bacterial infection or duct obstruction. It gives



[Table/Fig-5]: Acute sialoadenitis with enlarged gland and showing generalised hypoechoic echotexture. Mild sialectasis noted in form of dilated duct.



[Table/Fig-6]: Showing well defined anechoic lesion with small solid area abscess. **[Table/Fig-7]:** Chronic sialoadenitis showing small heterogeneous gland. Adenoma is also noted. **[Table/Fig-8]:** Atrophic heterogeneous submandibular gland in a patient of Sjögren's syndrome. Parotid involvement was also noted. (Images from left to right)

pseudo tumour like appearance and for confirmation of diagnosis biopsy or excision is required. On high frequency ultrasound the lesions appear as focal hypoechoic areas and can mimic tumours. Color flow Doppler examination shows a radial branching vascular pattern within the mass [5].

Non-infective Sarcoidosis: Parotid gland is most frequently involved in this chronic non caseating granulomatous condition.

Submandibular gland is rarely involved. It presents with painless enlargement. Ultrasound features of submandibular gland involvement are not well described. Few authors have described the appearance similar to parotid gland involvement [6]. The variety of manifestations includes multiple hypoechoic foci, diffuse hypoechoic glandular enlargement and associated lymphadenopathy [4,6]. Color Doppler may show increased vascularity. Necrosis is not visualized and this feature helps in differentiation from tuberculosis [7].

Sjögren's Syndrome

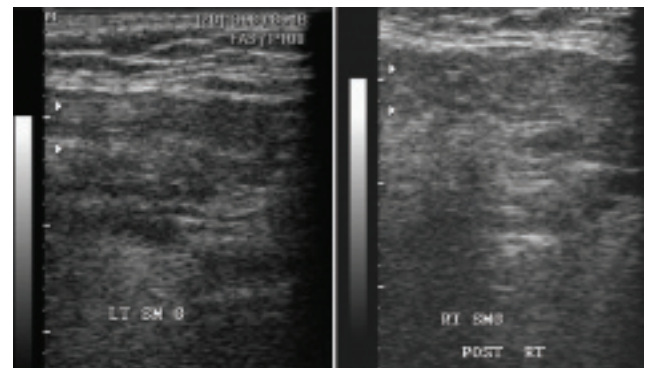
It is an autoimmune syndrome affecting middle-aged women. Around 80% cases have parotid or submandibular gland enlargement [3]. Prior knowledge of the pathology is helpful in understanding the various ultrasound appearances. Initially there is intraglandular duct dilation and destruction of the gland tissue predisposing to recurrent infection. The progression of disease changes the ultrasound features.

On high frequency ultrasound initially the gland may be normal. There may be diffuse gland enlargement, inhomogeneity and then sialectasis. Color Doppler imaging often shows increased vascularity [8]. There is usually concurrent involvement of lacrimal glands. In later stages numerous cystic spaces are seen due to progressive glandular destruction and prominent intra glandular sialectasis [8,9] [Table/Fig-8].

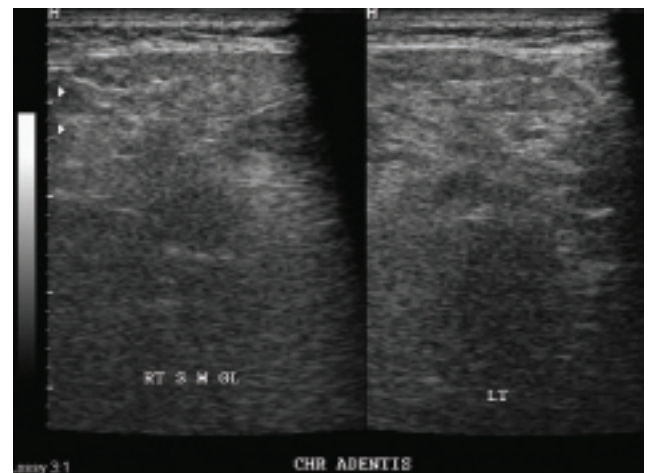
Radiation

The incidence of tongue, buccal mucosa and pharyngeal

malignancy is significant. More often the patients are subjected to radiotherapy. The submandibular gland shows generalized atrophy in these cases [Table/Fig-9,10].



[Table/Fig-9]: Bilateral atrophic gland after radiation therapy.



[Table/Fig-10]: Bilateral small glands post radiation

Neoplasm

The incidence of salivary gland neoplasm is low and is around 3% in the general population.

Parotid gland involvement is more frequent. Around 14% of salivary gland neoplasms occur in the submandibular gland and approximately half of them are malignant. This is in contrast to parotid gland neoplasm where only 10% are malignant [10]. The higher chance of malignancy warrants vigilant examination of the submandibular gland and in case of suspicion, cytology should be advised. High frequency ultrasound is an excellent tool to guide the Fine Needle Aspiration (FNA) or core biopsy of the lesion to confirm its nature. While FNA is quicker and safer technique, core biopsy has potential advantages [11].

Benign

Pleomorphic adenoma is the most common benign neoplasm [1]. They appear as circumscribed, round, hypoechoic masses with a lobulated border. They may show posterior acoustic enhancement on high frequency ultrasound [3]. A quarter of adenomas are associated with satellite lesions. Larger adenoma shows area of hemorrhage, necrosis, calcification or cystic changes [Table/Fig-11-14] [9]. If the long standing mass grows rapidly and patient experiences pain there is likely malignant transformation.

Lipoma represents small number of submandibular tumours. They are compressible, oval and well-defined [12]. On ultrasound they contain striped or feathered internal echo pattern. On color Doppler no flow is demonstrated in the lesion [Table/Fig-15].

Warthin's tumour (Cystadenolymphoma) is very rare in the submandibular gland. This is due to early encapsulation of the submandibular gland during fetal development. This prevents structures viz. lymphatics, vessels and nervous tissue developing within the gland. Parotid gland on the other hand undergoes delayed encapsulation and lymphatic pathologies are relatively more common.

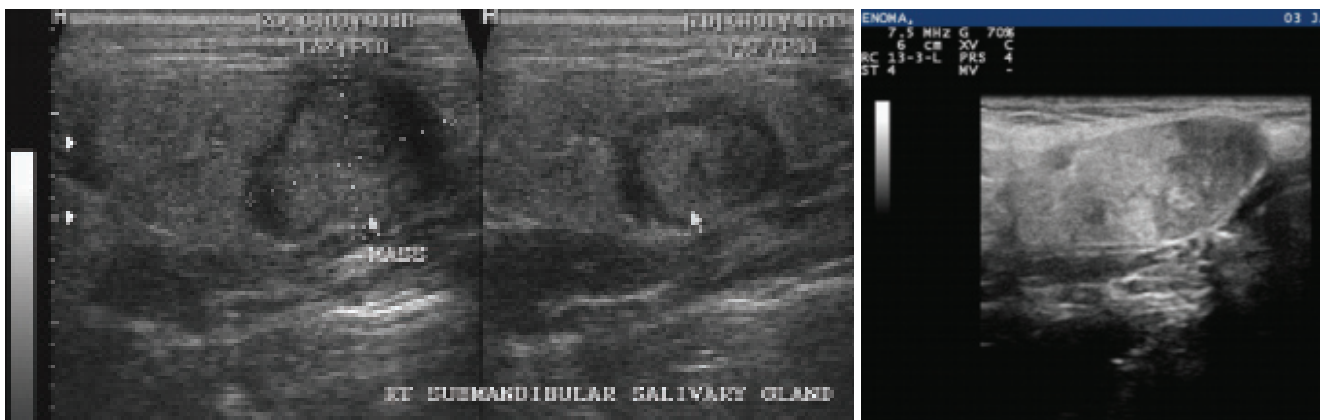
Oncocytoma occurrence is about 1% of all salivary gland neoplasm and around 11 % of them occur in the submandibular gland. Histologically, oncocytoma is composed of oncocytes derived from striated duct cells. The ultrasound appearance is similar to pleomorphic adenoma and may undergo malignant transformation [10].

Malignant

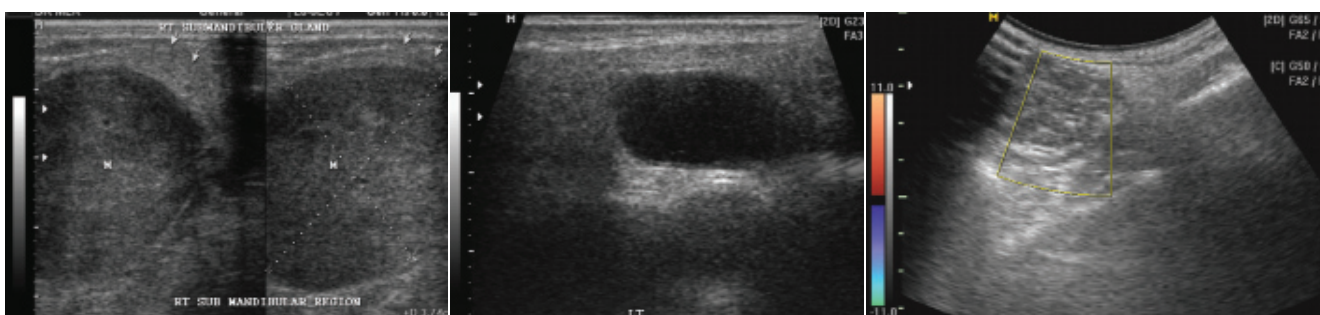
Adenoid cystic carcinoma accounts for 17 % of the malignant tumours of submandibular gland [10]. It occurs in fifth or sixth decade of life. The tumour can be multiple, has a propensity for perivascular and perineural spread and can metastasize to regional lymph nodes, lung and bone [8].

Other primary malignancies are mucoepidermoid carcinoma, acinic cell carcinoma and adenocarcinoma which are rare [10].

In around 80% of cases, high frequency ultrasound can



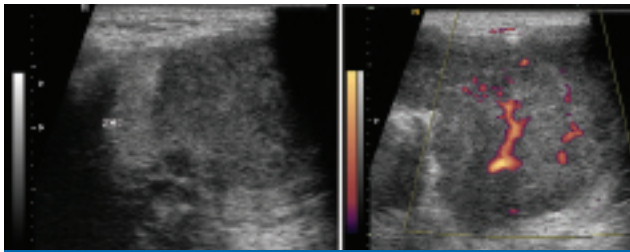
[Table/Fig-11]: Adenoma showing well defined hypoechoic nodular lesion. [Table/Fig-12]: Another case of adenoma. (Images from left to right)



[Table/Fig-13]: Large adenoma. [Table/Fig-14]: Showing cystic adenoma. [Table/Fig-15]: Showing hyperechoic lesion with striated appearances indicative of lipoma. (Images from left to right)

distinguish benign from malignant lesions. In addition it can demonstrate extra capsular spread and any regional lymph node involvement. The histological subtyping necessitates cytology of the lesion.

The malignant lesions appear as masses of heterogeneous echotexture with irregular infiltrating borders, and associated posterior acoustic shadowing. On color Doppler examination, malignant tumours may show multiple, irregular internal vessels, with hypervascularity and high resistance arterial flow [8]. Due to high incidence of malignancy in submandibular gland histological examination should always be done even if there are features suggesting benign lesion. This is because small and low grade malignant lesions may appear benign on ultrasound [Table/Fig-16].

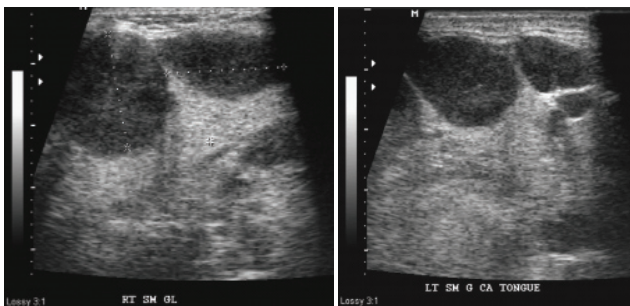


[Table/Fig-16]: Large mass showing heterogeneous echotexture. Doppler shows abnormal vascular pattern.

Lymphoma

Primary lymphoma is very rare as stated above. The gland may be involved secondarily via haematogeneous spread [7]. Primary disease may occur in patients with Sjögren's syndrome who are at significantly increased risk of developing a non-Hodgkin's lymphoma in particular [12]. The ultrasound features of lymphoma are described as solid, hypoechoic or pseudocystic masses [Table/Fig-17] [13].

Metastasis



[Table/Fig-17]: Submandibular gland showing hypoechoic nodular lesions metastasis in lymphoma. **[Table/Fig-18]:** Submandibular gland showing metastasis in carcinoma tongue. (Images from left to right)

Metastases to the submandibular gland are rare, occurring mainly as a result of haematogeneous spread. These are mainly from head and neck tumours or melanoma. The ultrasound

features of submandibular gland metastases are not well described, although the appearances are likely to be similar to those demonstrated in parotid metastatic disease [13,14]. They tend to be hypoechoic, with heterogeneous internal architecture and poorly defined margins [Table/Fig-18].

CONCLUSION

High resolution ultrasound is a simple, readily available, non-invasive and reliable imaging tool for the evaluation of the submandibular gland diseases. It gives definite information about location, size and extent of submandibular disease. The nature of lesion can be ascertained in most of the cases. It is used as a guide for FNA or biopsy of the gland and abscess drainage.

Ultrasound is a substitute for other imaging in many of the pathologies. It also suggests necessity of further imaging in some diseases.

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FINANCIAL OR OTHER COMPETING INTERESTS:

None.

Date of Publishing: **Apr 01, 2017**