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Role of Ultrasonography in Salivary Gland Health and Disease – A Review

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Abstract*: Since the dawn of time when the pathologies of salivary glands were unknown to mankind, various imaging modalities have played instrumental role in their identification. The diagnostic algorithm for imaging salivary gland includes Plain Film Radiography, Contrast Enhanced Radiography, Sialography, Scintigraphy, Computed Tomography (non-enhanced and contrast enhanced), Magnetic Resonance Imaging (non-enhanced and contrast enhanced), Nuclear Medicine and Ultrasonography. In radiographic evaluation, patients are exposed to multiple radiographs which can result in radiation effects at the tissue and organ level. Though Sialograpy is a conventional diagnostic tool but it is invasive due to cannulation and injection of contrast material. Cannulation of main duct might be difficult especially in case of atrophied duct or in cases of hyposalivation. Out of all imaging modalities, MRI and ultrasonography are the only two which are devoid of inevitable radiation hazards. MRI examination is too expensive to be routinely advised and is contraindicated in patients with cardiac pacemakers or claustrophobia. Thus, Ultrasonography is a promising imageology because of many factors like non-invasive, lack of ionising radiation, instant results, inexpensive and readily available. In this article, authors have focussed on the role of ultrasonography in imaging salivary glands in healthy and diseased states.*

Keywords*: ultrasonography, salivary gland, acoustic, diagnostic imaging, therapeutics*

I. Introduction

Salivary gland disorders are routinely encountered in dental practice.Different imaging modalities have been discovered which aid in earlier diagnosis and better outcome of the salivary gland pathologies.[1] Computed Tomography (CT) examination is considered to be best for the assessment of salivary gland inflammatory diseases and MRI for tumours of salivary glands.[2]According to ***Yousem***, ultrasonographic examination by qualified person can supplant both CT and MRI examination in evaluation of superficial salivary gland lesions. Review of literature states that ultrasonography is superior modality than CT and sialography. It helps not only in detection of sialoliths and tumourous lesions but also in describing the structure and vascularity of such lesions.[3]

The inception of ultrasonography in diagnostic imageology occurred way back in early 1950.[4] By virtue of its unique properties like lack of radiation hazards, non-invasive, broad spectrum imaging, affordable pricing , instant results and ready availability, it emerged as a promising tool both in the dental and medical diagnostics and therapeutics.[5-8]Unlike x-rays, sound waves require medium for transmission. The velocity of Ultrasonographic (USG) waves is lowest in gases, intermediate in liquid and highest in solids. In human body all tissues except bone behave as liquids and thus they transmit sound at about same velocity. The average velocity for body tissue is approximately 1540m/sec.[4]In diagnostic ultrasonography,high frequency sound waves are transmitted into the desired body area by a device called transducer. Transducer possesses piezoelectric effect i.e. the ability to convert sound waves into electrical waves and vice versa.The waves are reflected from the tissue and this echo is detected from the tissue interface and displayed onto the screen.[4,5]

Ultrasonography in dentistry has been used for viewing healthy and diseased states involving hard and soft tissues of the oral and maxillofacial region. It is used for detection of fractures, inflammatory conditions, cystic lesions, tumours, lymph node involvement, sialoliths and detecting muscle mass etc.[9-11]Ultrasound can also be used during FNAC, FNAB. Color Doppler ultrasound can be used for identify vascular supply and vascular lesions.In this paper we will discuss the applications of ultrasound in diagnosis of salivary gland disorders.[10-16]

II. Technique Of Ultrasonographic Examination

USG examination should be carried out with highest frequency transducer. 5-12 MHZ wide band linear transducer with a median frequency of 7.5MHZ gives satisfactory results. For large and deeply seated tumours, 5-10MHZ transducers should be used. For evaluation of internal structure of salivary gland, probes with median frequency more than 10MHZ should be used.[17] Patients should be scanned in supine position with their neck extended and head turned a little towards the opposite side. The entire salivary gland should be scanned in at least two perpendicular planes. Ultrasonography of neck is essential to assess the status of lymph nodes and search for concomitant diseases.[18]

III. Ultrasonographic Features Of Most Common Pathologic Conditions

Before proceeding with the ultrasonographic examination, one should be well versed with the knowledge of anatomical structures and their relations. In the following paragraph, we have discussed ultrasonographic features of healthy salivary glands

Parotid Gland

The parotid gland is located in the retromandibular fossa, anterior to the ear and sternocleidomastoid muscle. The border between the superficial and deep parotid lobes is created by a plane in which the facial nerve and its branches are located but they are not visible on ultrasound.Thus, the retromandibular vein, which usually lies directly above the trunk of the facial nerve, is used as a landmark in USG examination.[19]The normal echogenicity of parotid gland, is homogeneous and varies from very bright and markedly hyperechoic to only slightly hyperechoic in comparison to adjacent muscles. Salivary glands with high fat content are hyperechoic in comparison to surrounding muscles and markedly suppress ultrasound waves.Along the course of the Stenson duct, an accessory parotid gland may be found. Lymph nodes are identified by the presence of characteristic hyperechoic hilum.[20]

Submandibular Gland

The submandibular gland lies in the posterior part of the submandibular triangle bounded on one side by the anterior and posterior bellies of the digastric muscle and on other by the body of the mandible. The submandibular gland may be connected with the parotid or sublingual gland by the glandular processes. The tortuousfacial artery and facial vein crosses the parenchyma of the submandibular gland .Wharton duct runs from the area of the submandibular gland hilum at the level of the border of the mylohyoid muscle.[20]

Sublingual Gland

The sublingual gland lies between the muscles of the oral cavity floor. On transverse sections, sublingual gland appears oval in shape while in sections parallel to the body of the mandible, the shape is longitudinal and lentiform. Along its medial part runs the excretory duct of the submandibular gland.[20]

IV. Salivary Gland Pathologies

- ***Acute inflammation:*** In acute inflammation, the salivary glands are enlarged and hypoechoic with increased blood flow. These may contain multiple, small, oval and hypoechoic areas. Enlarged lymph nodes with increased central blood flow may be observed in acute inflammation of salivary glands.
- ***Abscess:*** During clinical examination, abscesses may be difficult to detect which can be identified using ultrasonography. Abscess appear as hypoechoic or anechoic lesions with posterior acoustic enhancement and unclear borders .[21]Hyperechoic foci due to microbubbles of gas may be seen within the abscess while organized abscesses may be surrounded by a hyperechoic halo.[20]
- ***Chronic nflammation****:* Chronic inflammatory conditions of salivary glands like chronic sialadenitis presents as intermittent painful swelling of the gland.The sonographic features are normal sized or smaller salivary glands which are inhomogeneous, hypoechoic, and do not have increased blood flow.[22] In Kuttner tumor (chronic sclerosing sialadenitis), diffuse involvement of the salivary gland occurs which presents ultrasonographically as multiple small hypoechoic foci scattered on a heterogeneous background of salivary tissue. In the parenchymal type of tuberculosis, focal, anechoic zones with a cavity withinthem are seen.[20]In inflammatory salivary gland diseases, lymph nodes may be enlarged, however with normal homogeneous cortex and hyperechoic central hilum.The ultrasonographic features of lymphadenitis include hilus which is an eccentric echogenic structure in hypoechoic lesion.[6,7]
- ***Sialolithiasis:*** USG features of sialolithiasis include strongly hyperechoic lines or points with distal acoustic shadowing. In symptomatic cases with duct occlusion, dilated excretory ducts are visible. The added advantage of USG examination especially in submandibular gland is that it can distinguish whether the stone is located in the glandular parenchyma or in the Wharton duct. Hyperechoic bubbles of air mixed with saliva may mimic stones in the Wharton duct and thus be a diagnostic pitfall.[23]

- ***Sialosis*:** In USG examination of patient with sialosis, ultrasound depicts enlarged, hyperechoic salivary glands with a poorly visible deep lobe but without focal lesions or increased blood flow.
- ***Sjogren Syndrome:*** The sensitivity of diagnostic accuracy of ultrasonography in sjogren syndrome ranges from 40-100%. ***Salaffi etal*** proposed a criteria for grading Sjogren's syndrome on the basis of ultrasonography as:[8]

Table showing Grading of Sjogren syndrome on the basis of ultrasonographic findings	
GRADE	**FINDINGS**
0(Inhomogeneity)	Normal gland
1(slight inhomogeneity)	Small hypoechoic spots
2 (mild inhomogeneity)	Multiple scattered hypoechoic spots(<2mm)
3(evident inhomogeneity)	Multiple hypoechoic spots(2-6mm)
4 (gross inhomogeneity)	Multiple hypoechoic spots(>6mm)

Shimizu et al reported that characteristic sonographicfindings(multiple hyperchoic areas, multiple hypoechoic spots surrounded by hyperechoic lines) could help differentiate positive cases of Sjogren syndrome from negative controls to a very significant degree.[24]

- ***Benign Neoplasms***:The most common benign neoplasms of major salivary glands are pleomorphic adenomas and Warthin tumors.[1]Ultrasonographically, Pleomorphic Adenoma are hypoechoic, well-defined, lobulated tumors with posterior acoustic enhancement and may contain calcification. Warthin's tumor is the next most common benign salivary neoplasm. Its ultrasonographic features include oval, hypoechoic, well-defined tumor which contains multiple anechoic areas.It may also present as a cyst.[3]Hemangiomas manifest as heterogeneous lesions with sinusoidal spaces and calcifications representing phleboliths.[11]Lipomas are usually oval and hypoechoic with sharp margins and hyperechoic linear structures regularly distributed within the lesion in a striated or feathered Neurogenic tumors often contain anechoic areas.[11,23]

- ***Malignant Neoplasms***: The most common malignant neoplasms occurring in salivary glands are mucoepidermoid carcinoma, adenoid cystic carcinoma, squamous cell carcinoma, acinic cell carcinoma, and adenocarcinoma. [3]USG features of malignant salivary neoplasms are an irregular shape, irregular borders, blurred margins, and a hypoechoic inhomogeneous structure.[12]Although vascularization of malignant tumors is not pathognomonic but Schick et al reported that high vascularization and high systolic peak flow velocity should raise the suspicion of malignancy. [25]On the contrary, Bradley et al reported that tumors associated with an increased intra-tumoral vascular resistance index are more prone to be malignant.[26]

- ***Metastases*:** Metastasis in salivary glands is a rare finding which may be due to tumours of head and neck region, melanoma, spinocellular cancer, breast cancer, and lung cancer. Ultrasonographically, metastases are well defined and oval which may be difficult to differentiate.[17,18]

- ***Cysts* :**USG features of a cyst are well-defined margins, anechoic content, posterior acoustic enhancement and no evidence of internal blood flow at colour doppler imaging.[13,20]

- ***Effects of Irradiation***: An irradiated salivary gland is hypoechoic and inhomogeneous at ultrasonographic examination.

POINTS OF DIFFERENTIATION BETWEEN VARIOUS SALIVARY GLAND TUMORS

Table showing differentiating features between benign and malignant tumours of salivary glands			
Characteristics	**Pleomorphic Adenoma**	**Warthin's Tumor**	**Malignant Tumor**
Borders	Clear	Clear	Ill Defied
Shape	Lobulated	Oval	Polygonal
Echo Intensity Level	Slightly Hypoechoic	Very Hypoechoic	Hypoechoic
Distribution Of Internal Echoes	Homogenous	Multiple Anechoic Areas	Heterogenous
Acoustic Enhancement	Enhanced Posterior Echo	Weak Enhancement Of Posterior Echo	Attenuated Posterior Echo

V. Conclusion

Ultrasonography offers non-invasive, inexpensive, concise and real time examination of salivary glands. It not only helps in detection of a salivary stone or any lump but based on incidental sonographic findings many latent underlying diseases can be instigated for further examination.

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