Review Article

Diagnostic Imaging of the Salivary Glands- A Review

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A B S T R A C T

Salivary gland disorders comprises of an important group of head and neck pathologies which come across in a day to day life of a General Dental Surgeon, ENT Surgeon and Oral & Maxillofacial Surgeon alike. Although a lot of refinement of the older techniques and advancement in terms of newer techniques have happened in this field of imaging studies, but it is always better to learn and understand each and every technique available for this special group of disorders. Further varied techniques are used to learn information on salivary gland structure and function, anatomical variations and space-occupying lesions within the glands. This article provides an overview of various diagnostic techniques available.

Keywords: Salivary Glands, Diagnostic Imaging, Radiography, Sialography, Flow Cytometry, FNAC

INTRODUCTION

Salivary gland disorders comprises of a small yet an important group of head and neck pathologies which comes across the clinical practise of a Dental Surgeon to an Oral Maxillofacial Surgeon, an Otolaryngologists or even a General Surgeon. There are various imaging techniques available towards the diagnostic approach of salivary gland disorders ranging from conventional radiography, ultrasonography (USG), computed tomography (CT Scan) to magnetic resonance imaging (MRI)[1] and so on. The purpose of these imaging techniques is to assist the doctor in making a precise diagnosis of the concerned salivary gland pathology.[2,3]

1. Plain-film radiography

1.1 Conventional Techniques

Since the salivary glands are relatively located superficially[1,2], a radiographic image can be made with a conventional radiographic technique. Plain film radiography is indicated in the cases of obstruction of salivary gland causing symptoms like pain and swelling of the affected gland in order to possibly visualize radiopaque salivary gland or duct stones. Following are some of the views for each type of major salivary gland:

Parotid Gland: Antero-Posterior (AP), Lateral Oblique and Panoramic view (OPG)

(Note: Panoramic views overlap certain anatomic structures which can mask the presence of a salivary stone)

Parotid Duct: Occlusal film placed intraorally adjacent to the parotid gland duct and opposite to maxillary molars would help to visualize any stone near the gland orifice. (Note: This technique will not capture the entire parotid gland)

Submandibular Gland and Duct: Occlusal, Lateral Oblique and Panoramic view (OPG)

1.2 Xeroradiography

It was first described by Boag in 1973 for imaging of the human body. This technique employs a thin layer of photoconductive selenium alloy deposited on an aluminimu substrate, which is subsequently electro-statically positively charged, stored with in a cassette, and used as a radiographic film. It has been found useful in imaging of the salivary glands. Specific feature like edge contrast enhancement especially helps in detection of radiolucent sialoliths.

2. Sialography

Sialography is the radiographic visualization of the salivary gland following retrograde instillation of soluble contrast material into the ducts.[2,4] Sialography was first mentioned by Carpy in 1902 and it is one of the oldest techniques written in the literature. In 1925, Evan it was described as a diagnostic tool separately by Barsony and Uslenghi.

Sialography is one of the most preferred technique and indicated for evaluation of the intrinsic and/ or acquired defects of the salivary glandular ductal system as it provides a clear visualization of the branching ducts and

acinus. The obstruction can be easily visualised upon sialography as to whether it is by a sialolith or a stricture. There is strong prediction of sialolith if the clinical history of the patient dictates an acute and rapid-onset painful swelling of a perticular gland which is typically brought on by eating a delicious food or taking drinks like lemon water which actually increases salivary flow.

The contraindications to sialography are active infection and allergy to contrast media. This procedure if performed during active infection may further irritate and potentially rupture the already inflamed gland. Further, the injection of contrast material may push concerned bacteria throughout the glandular ducts to worsen the condition of the patient especially if he/ she is already medically compromised. The iodine present in the contrast media is thought to induce an allergic reaction. Oil- and water based contrast media are available. Both contain iodine and are therefore contraindicated in patients with iodine sensitivity.

Oil-based contrast material provides opacificaton of the ductal and acinar structures by virtue of its property of not being diluted in saliva or absorbed across the mucosa. Injection of oil-based contrast medium requires more pressure because of its viscosity. Examples are Iodized oil (e.g. Lipiodol) and Water insoluble organic compounds (e.g. Pantopaque).[2,4]

Water-based dyes are normally soluble in saliva and can therefore diffuse into the gland resulting in decreased radiographic density and poor visualization of structures as compared to any oil-based contrast. A high viscosity, water-soluble contrast agents that allow better visualization of the ductal structures are also available and are always preferred. These are actually iodinated benzene or pyridine derivatives. Examples are Hypaque. 50% and 75%, Renograffin 60, Sinograffin.

The choice of radiography includes OPG, Anterio-Posterior, puffed-cheek AP views and Lateral Oblique X Ray. Computerized Tomography or Magnetic Resonance Imaging are normally indicated for visualising neoplasms of the salivary gland.

Phases of imaging

Preliminary plain film: in the AP, lateral and oblique positions.

Injection / filling phase film: AP, lateral and oblique. These films should be obtained under image amplification control. Serial spot films should be taken showing the gland in different profiles.

Post evacuation / parenchymal phase film: these are films completed 5 minutes after emptying phase in the AP, lateral and oblique positions. If these films show media retention, films should be taken after 1 hour and then 24 hours.

3. Computerised tomography (CT) and MAgnetic resonance imaging (MRI)

CT and MRI are some of the advanced and finer imaging techniques used to evaluating the salivary gland pathologies, adjacent normal structures, and the proximity of salivary lesions to some of the vital structures like facial nerve, retromandibular vein, carotid artery, lymph nodes etc. Computed tomography (CT) images are produced in all the 3 planes viz. Coronal, Saggital and Axial. A reconstructed image can then be formed by a computerized analysis of the variance of absorption produced in all the three planes.

Magnetic Resonance Imaging (MRI) uses the varying water content of body tissues to distinguish between them. When exposed to a strong electromagnetic field, tissues absorb and then re-emit electromagnetic energy. An analysis of the net magnetization by radiofrequency is then reconstructed on computer software to provide the image. Images are described as T1- or T2-weighted images, depending upon the rate constant with which magnetic polarization or relaxation occurs.

CT scan and/ or MRI is useful for determining the outer extent of large tumors, any extra glandular extension, and the actual depth of such tumors. Additionally, they are helpful in distinguishing between 2 different tumors which are in close proximity to each another and for evaluation metastasis of cervical lymph nodes. CT-guided needle biopsy is useful to evaluate certain anatomically deep areaslike the parapharyngeal space.

Gadolinium-enhanced dynamic MRI can be used to differentiate a benign tumor like pleomorphic adenoma from a malignant tumors by using peak time of enhancement. Similarly, heavy T2-weighted MRI scans can delineate Warthin tumors from pleomorphic adenomas based on signal strength.

4. Positron emission tomography (PET)

Positron emission tomography CT (PET/CT) provides a relatively non invasive method of imaging that can be used to study patholocical and physiological processes in the body, with the added advantage of anatomical localization. PET scanning uses of radiotracers, which subsequently decay, with the emission of positively charged particles (positrons). These positrons travel a few millimetres in tissue before combining with negatively charged electrons, converting mass into energy and releasing two high energy (511 keV) photons (gamma rays) which are emitted at approximately 180° to each other. The simultaneous detection of these positrons by opposing detectors is then used to construct a three dimensional image of these events known as PET image. CT data is also obtained during scanning and the PET data is combined with CT that helps localize these radiotracer. The main application of PET/CT is in the assessment of patients with cancer using the glucose analogue 2-[18] fluoro- 2-deoxy-

D-glucose (FDG) since the cancer cells have increased glucose utilization.[6] FDG PET/CT plays a very vital role in the management of head and neck cancer.

5. Ultrasonography

Ultrasonography (USG) is helpful to visualize superficial structures like the parotid and submandibular glands, although the deep portion of the parotid gland is difficult to visualize because the presence of bony ramus which lies over the deep lobe. Ultrasonography is also helpful to differentiate between intra glandular and extra glandular masses as well as between solid or cystic mass.[2,7] Now a days, the availability of high-resolution probes and harmonic imaging are available which help to delineate location, homogeneity or heterogeneity, shape, and margins of salivary tumors. Newer ultrasonographic contrast mediums can even reveal the amount of vascularity of the tumor before actual surgery.

Ultrasonography can guide fine-needle aspiration up to the precision of 97% of the time in an outpatient setting, thereby reducing the need for any intraoperative biopsies. Ultrasonography can also guide automated core biopsy systems with a sensitivity of 75%, specificity of 96.6%, and accuracy of 91.9%.[7]

6. Radionuclear imaging

Myant et al in 1950 introduced this functional diagnostic and morphological technique basing their approach on the work of Schiff in 1946. Schiff in 1946 observed that iodine 131 can be concentrated in salivary glands and eliminated by saliva. A scan revealed the presence of "hot" nodules. Technetium 99 was tried in 1960 and found more suitable. It was injected intravenously as pertechnetate compounds.

Scintigraphy with technetium (Tc) 99m pertechnetate is a minimally invasive diagnostic imaging technique used to assess the salivary gland function and to determine abnormalities in glandular uptake and excretion.[9,14] Scintigraphy is possibly the only salivary imaging technique providing information on the functional capabilities of the glands. Following intravenous injection of technetium(which is a pure gamma ray–emitting radionuclide), it is taken up by the salivary glands, transported and secreted into the oral cavity. Uptake and secretion phases can then be recognized on the scans. The uptake of Tc 99m by a salivary gland indicates any functional epithelial tissue presence. The Tc-99m scan being able to correlate well with salivary output can be used as a measure of secretory function.

Scintigraphy is indicated for the evaluation of patients when sialography is contraindicated or cannot be performed, such as in cases of acute gland infection or iodine allergy, or in cases where the major duct cannot be cannulated successfully. It is a useful adjunt to aid in the diagnosis of salivary gland duct obstruction, salivary stones, glandular aplasia and Sjogren's syndrome. The imaging is performed following the injection of 10 to 20 mCi of Tc 99m pertechnetate and the uptake, concentration, and excretion of the pertechnetate anion by the glands and other organs is imaged with a gamma detector which records both the number and the location of gamma particles released in a given field during a certain period of time. The information can be stored in a PC for analysis and/ or recorded directly on X ray film from the gamma detector to produce images.

There are several rating scales for evaluating the salivary scintiscans yet there is no standard rating method as of now. The prevailing approaches to functional assessment include visual interpretation, time-activity curve analysis, and numeric indices. Most radiologists read Tc 99m scans by using visual interpretation along with clinical judgment of the interpreter. Although a semi quantitative method exists in which Tc 99m uptake and secretion is calculated by computer analysis of a user-defined region of interest, these time-activity region of interest studies are quite time-consuming and mostly used for research purpose.

7. Fine-needle aspiration cytology

FNA cytological diagnosis is a relatively safer and fairly non traumatic method that may provide information about the nature of a glandular lesion. FNAC may distinguish benign from malignant tumors and provide a relatively accurate diagnosis in a good number of cases. Since the cytological features of the more common salivary tumors are already well documented in literature, it can be used to understand a cytological diagnosis in most cases. Diagnostic accuracy reported in most series is about 80 to 95%. Cytological diagnosis using fine-needle aspiration (FNA) may be a supplementary tool to many other techniques that investigate tumor mass like an ultrasonography and/ or a MRI. Although, the role of FNA cytology (FNAC) remains controversial since some authors argue that most parotid tumors require surgery and consider preoperative FNAC to have little influence on therapeutic management[8-10], but the information obtained from this fairly simple and relatively non invasive technique can never be overstated. Overall sensitivity of FNAC in distinguishing between benign and malignant salivary gland tumors is about 95%. Its specificity is about 98%. FNAC has a positive predictive value of approximately 84% and a negative predictive value of approximately 77%.[9] Some of the common complications of FNAC are non diagnostic biopsy, tissue changes occurring after excision (that may interfere with histological evaluation), and needle tracts and infarction.

8. Flow cytometry

Flow cytometry helps in detecting possibly malignant tumors thereby assisting in the diagnosis obtained from histopathology.[9] Flow cytometry helps in determining the DNA ploidy of tumor cells thereby helping in understanding the prognosis in certain tumors like

adenoid cystic carcinoma. Such information helps to estimate long-term disease-free survival period of the patient.

Determining aneuploidy versus diploidy by flow cytometry has been found to help grade mucoepidermoid carcinomas by one of the reported study in literature[10], the findings of which states that the high grade cancers are aneuploidy 89% of the time whereas the diploid cancers are low or intermittent grade 88% of the time.

CONCLUSION

The awareness and understanding of various imaging techniques, as applicable in the field of salivary gland pathologies, shall be an important aspect of a medical professional in order to reach to a clear understanding of the pathology, making a definitive diagnosis and drawing a precise road map towards a successful treatment and a better prognosis.

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