



Role of nuclear medicine in dentistry

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ABSTRACT

Nuclear medicine studies often play a significant role in the diagnosis and treatment of oral and maxillofacial diseases. While not commonly used in everyday dental practice, the dental provider should have a conversational knowledge of these imaging modalities and understand the indications and limitations of these studies. The purpose of this review is to discuss the nuclear medicine studies that have applications in the head and neck region as well as their indications, limitations, and diagnostic conclusions that can be drawn from these studies.¹

Keywords: Nuclear medicine, bone scan, SPECT, PET, lymphoscintigraphy, sentinel node

INTRODUCTION

Nuclear medicine has become an advanced diagnostic procedure in all fields of medicine. Advanced procedures like Single Photon Emission Computed Tomography (SPECT), positron emission tomography (PET), etc, hold lot of promise in all diagnostic areas, including dental arena.² However, nuclear medicine is relatively poorly understood with respect to dental applications and is under-utilized in oral and maxillofacial pathologies. The diagnostic modalities of nuclear medicine in oral and dental practice should be increasingly considered and an increased awareness in dental surgeons is needed. Its application in diagnostic as well as therapeutic fields of oral/maxillofacial pathologies needs discussion and emphasis.

Computed tomography

Computed Tomography (CT), along with magnetic resonance imaging (MRI) are techniques present for long and provide good images of both soft as well as hard tissues.⁴ However, though some of the nuclear imaging modalities may provide little physiologic insight into disease process, nuclear medicine techniques/scans are able to detect the pathologic disease/ abnormalities at an earlier stage than a CT or MRI and even before there is any evidence of morphological changes.¹⁷ The principle of nuclear medicine can be simplified into a procedure which detects and produces an image of quantity as well as distribution of radioactivity of the injected isotope in a particular tissue studied.⁹ Various modalities are discussed with an aim to benefit dental healthcare providers.

Bone Scanning

Bone Scanning is a nuclear medicine technique, which is possibly one of the most commonly performed diagnostic procedures.¹⁸ It uses technetium ^{99m} methylene disphosphonate, which taken in bony areas of high metabolic osteoblastic activity or vascularity. Normal bone should be symmetrical from midline and demonstrate uniform radioisotope uptake.

Bone scans are quite helpful in diagnosing and differentiating body infections from soft tissue infections e.g. dental osteomyelitis from cellulitis. While osteomyelitis shows more focal uptake in later phases. Both benign as well as metastatic bone tumors of oral regions show an increased uptake; however, this is non-specific and increased uptake can be seen in other metabolic diseases like fibrous dysplasia and Paget's diseases.⁹ Apart from that, increased uptake of isotopes is seen in inflammatory conditions of temporomandibular (TMJ) joints. However, the same is also to be correlated with clinical assessment (including history and clinical examination) as well as other investigations, for correct diagnosis.

There are some confounders of bone scan which pose difficulties in some conditions and clinical situations. Periodontal disease, which is active, may show increased radioisotope in mandibular and maxillary alveolar process, or arthritis may present as increased cervical spine activity and children who are growing generally show higher activity in the epiphyses. Decreased uptake of radioisotope in bone scan is seen in lesions resulting from radiation-necrosed tissue and prosthetic joint implants. In oro-chronic inflammatory changes should be considered in bone scans, with series of images of radioactive distributions use SPECT. These produce images in 3 planes and help in more accurate understanding and localizing specific target bone damage. SPECT images are used in pathologies of TMJ disease, with MRI equivalent sensitivity.¹²

Gallium Scan

Gallium scan are used in detecting abscesses, osteomyelitis and lymphomas. Although not a favorite test, suspicion of osteomyelitis in dental and other areas can be confirmed and diagnosed effectively by Gallium scan. Though triple phase bone scan test is the choice for osteomyelitis, it is non-specific and Gallium imaging increases the specificity of positive bone scan. Gallium scan is also used to monitor treatment response, with reduced Gallium intake/accumulation indicating improvements in osteomyelitis.¹⁶

Salivary Glands Studies

Most salivary glands can be imaged and scintigraphy of glands is used for evaluation of normal functioning as well as lesions. Radioactive substance with affinity for particular tissue is administered, with radioactivity measured by a scintillation camera. Gland aplasia/agenesis, obstruction, trauma as well as fistulas in glands can be detected and though there are exceptions. Further, acute inflammation usually shows increase in uptake, while decrease intake is seen in chronic inflammatory states.¹⁴

Position Emission Tomography

The use of PET scans as an imaging modality has been increasing and is helpful in evaluating metabolic reactions in the body.¹⁰ PET scans are usually useful in oral squamous cell carcinoma (OSCCA) and is able to detect pathology earlier than CT scan or a MRI. PET scan detect OSCCA at a stage when there are no palpable nodes in the neck and is considered promising in this respect. Response to tumor treatment, diagnosing recurrence, detecting residual pathology and distant metastases are effectively done by PET scan.⁷ PET scan is also often helpful localization of occult primary tumor.¹³

However, PET scan gives false positive results too. Accumulation and uptake may be seen in non-neoplastic tissue; e.g. new granulation tissue, inflammatory areas and postoperative scarring, especially in early stages. Recent irradiation treatment in the OSCCA neck would give false positive results. False positive results are seen with tuberculosis and sarcoidosis. Overall speaking,

though specificity in PET scan is high, sensitivity is an issue.

Lymphoscintigraphy

Lymphoscintigraphy is showing excellent promise in oral malignancies and is an interesting scan modality. Already being used routinely in breast cancer and malignant melanoma,¹¹ detecting oral malignancies seem to be effective with this technique. The radioactive contrast is taken up through lymphatic channels to the first level of draining lymphatic area,³ which is generally called the sentinel node and lymphatic spread pattern. Metastases are usually evaluated in sentinel node and other nodes are considered free from disease if the sentinel node does not show any positive involvement. Sentinel node mapping has helped lot of breast cancer patients, by sparing many axillary nodal dissections/persistent upper extremity lymphadema,⁸ and is considered promising for the same reasons in oral carcinomas. Many research studies are trying to evaluate the accuracy of sentinel node biopsy in management of oral carcinoma.

SPECT

The SPECT technology can be used in bone scans. With SPECT, the tomographic images are obtained in three planes (axial, coronal and sagittal), which thereby facilitates more accurate interpretation and better localization of bone pathology. In contrast to planar bone scanning, SPECT uses tomographic technology to provide 3-dimensional images, which are most useful in localizing small lesions.⁵ It is understood that SPECT bone scanning with Tc-^{99m}MDP cannot be routinely used for detection of jaw pathoses, however it can be regarded as a potential research tool in the future study of chronic idiopathic jaw pain.

Accurate imaging methods are required to assess the mandibular invasion of squamous cell carcinoma (SCC). In such a situation, a negative bone SPECT

rules out mandibular invasion. And thereby, the inclusion of SPECT in the preoperative assessment would reduce unnecessary mandibular resections.⁶

Single photon emission computed tomography has been considered as a useful aid in diagnosing and subsequently determining in the therapeutic course in patients with asymmetrical mandibular condylar hyperplasia.¹⁴

In certain oncology patients treated with biophosphonates, an increased uptake of 99mTc-methylene diphosphonate in maxillary bones may suggest probable osteonecrosis of the jaw. Therefore in such cases, SPECT/CT is considered of diagnostic value in assessing the extent of the disease.¹⁵

Single photon emission computed tomography is advantageous in implant dentistry where the influence of immediate prosthetic loading on peri-implant osteoblastic activity can be assessed. Additionally, it has been observed that SPECT can be used to assess the osseous integration process of dental implants.¹⁷

CONCLUSION

Nuclear diagnostic techniques are being used commonly in routine practice, and it is important for the dentists to be familiar with commonly used scans in nuclear medicine with respect to oral lesions. Oral lesions often overlap with dental pathologies and dental practitioners should be well versed with the various indications for nuclear imaging techniques in oral/dental pathologies. Interpretation of the scan results, as well as shortcomings of the scan are important to understand, as they may be required at times to be done by the dental surgeons. Bone scan, SPECT imaging and PET scans are techniques that help in diagnosing oral/dental pathologies and tumors in the surrounding periodontal/oro-maxillary regions, which may have to be dealt by dentists at initial stages, though may later require an oncologist.

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