ROLE OF PET/CT IN DIAGNOSIS AND EVALUATION OF HEAD AND NECK TUMORS

Submitted For Partial Fulfillment of the MD Degree in Radiodiagnosis

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ABSTRACT

Aim of work: The objective is to study the role of PET/CT in the initial diagnosis and staging of patients with head and neck tumors, the overall clinical outcomes as well as in evaluation of treatment response and detection of recurrence. Comparing the PET/CT with the contrast enhanced CT.

Setting: 69 patients with Head and Neck tumors had 83 PET/CT examinations.

Results: FDG-PET/CT in head and neck cancer yielded additional diagnostic information in 51% of patients, with subsequent treatment plane change in (41.7%) of patients in the study. In our study PET/CT was significantly superior to CT concerning diagnostic accuracy in patients with head and neck cancer for assessment of treatment response and recurrent disease, with specificity, sensitivity, NPV, PPV, and accuracy of 27%, 74%,30%,71%,60% consecutively for CT and 91%,92%,83%,96%, and 92% consecutively for PET/CT.

Conclusion: PET/CT is an imaging modality with high diagnostic performance in the assessment of head and neck cancer, and induced a significant change in further patient's clinical management.

KEY WORDS

Role

Diagnosis

evaluation

TABLE OF CONTENTS

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LIST OF FIGURES

Number *Page*

LIST OF TABLES

LIST OF ABRREVIATIONS

[F-18]: 2-deoxy-2-fluoro-D-glucose

AAO-HNS: The American Academy of Otolaryngology & Head and Neck Surgery

ACS: Anterior cervical space

AE: Aryepiglottic

AJCC: American Joint Committee on Cancer

BS: Buccal Space

CECT: Contrast Enahnced Computed Tomography

CNV: Cranial Nerve

CRT: Chemoradiotherapy

CS: Carotid Space

CT: Computed Tomography

DL-DCF: Deep layer, deep cervical fascia

EAC: External Auditory Canal

ECOG: Eastern Cooperative Oncology Group

ECS: Extracapsular Spread

ETOH: Ethanol

FDG: Fluorodeoxyglucose

FN: False Negative

FP: False positive

FVC: False Vocal Cords

GTV: Gross Target Volume

HNC: Head & Neck Cancer

HNSCC: Head & Neck Squamous Cell Carcinoma

HPV: Human Papilloma Virus

IHN: Infrahyoid Neck

IMRT: Intensity-Modulated Radiation Therapy

LMG: Lethal Midline Granuloma

LRF: Locoregional Failure

ML-DCF: Middle layer, deep cervical fascia

MRI: Magnetic Resonance Imaging

MS: Masticator Space

MSG: Minor Salivary Glands

NPC: Nasopharyngeal Carcinoma

NPV: Negative Predictive Value

OMC: Ostiomeatal Complex

PCS: Posterior cervical space

PES: Pre-epiglottic Space

PET: Positron Emission Tomography

PET-BTV :18F-FDG PET-defined biologic target volume

PGS : Paraglottic Space

PMS: Pharyngeal mucosal Space

PPF: Pterygopalatine fossa

PPS: Parapharyngeal Space

PPV: Positive Predictive Value

PS: Parotid Space

PTLD: Post-transplant Lymphoproliferative Disorders

PVS: Perivertebral spaces

RPS: Retropharyngeal Space

RT: Radiation Therapy

SCCa: Squamous Cell Carcinoma

SER: Sphenoethmoidal recess

SHN: Suprahyoid Neck

SL-DCF: Superficial layer, deep cervical fascia

SN: Sinonasal

SUV: Standardized Uptake Value

TN: True Negative

TP: True Positive

TVC: True Vocal Cords

UPC : Cervical Unknown Primary Carcinoma

VS: Visceral space

WHO: World Health Organization

Chapter 1

Introduction

Head and neck cancers constitute approximately 5.4% of all cancers globally. Treatment of head and neck tumors is challenging. It is a multidisciplinary approach that includes medical oncology, radiation therapy, surgery, and radiology results in optimal patient care. **(1)**

Accurate initial staging is critical in the treatment of patients with head and neck cancer. MRI and CT remain the primary imaging modalities for the assessment of head & neck squamous cell carcinoma (HNSCC), but 18F-FDG PET/CT has emerged as a vital adjunct when used in the appropriate clinical setting. Although CT and MRI are superb cross-sectional imaging techniques, 18F FDG PET/CT combines the excellent anatomic detail of CT with metabolic activity data from 18F FDG PET in a single imaging session, thereby increasing the accuracy of initial staging in these patients. **(1)**

Pre-treatment PET scans have been incorporated in the staging work up of head and neck cancer patients in an increasing number of centers. A number of groups (reviewed by Vermeersch, et al) have shown FDG-PET to have higher staging sensitivity and specificity for de novo or recurrent head and neck cancer than clinical examination, CT, or MRI. Combined PET/CT imaging has an advantage over PET imaging alone by providing greater sensitivity and more precise anatomic localization of FDG uptake with corresponding CT information.**(2)**

With CT and magnetic resonance imaging in head and neck cancer, the sensitivity for detection of lymph node involvement ranges from 60% to 88%, and the specificity ranges from 58% to 86%. PET is both more sensitive (70%–95%) and more specific (78%–97%) than conventional imaging. FDG PET/CT improved detection of smaller nodes in head and neck metastatic adenopathy. **(3)**

For the past 5 years, combined positron emission tomography (PET) and computed tomography (CT), or PET/CT, has grown because the PET portion provides information that is very different from that obtainable with other imaging modalities. However, the paucity of anatomic landmarks on PET images makes a consistent “hardware fusion” to anatomic cross-sectional data extremely useful.

Clinical experience indicates a single direction: Addition of CT to PET improves specificity foremost, but also sensitivity, and the addition of PET to CT adds sensitivity and specificity in tumor imaging. Thus, PET/CT is a more accurate test than either of its individual components and is probably also better than side-by-side viewing of images from both modalities. PET/CT appears to provide relevant information in the staging and therapy monitoring of many tumors. **(4)** Unlike anatomical imaging techniques such as CT and MRI, positron emission tomography (PET) is a "physiological" imaging technique. The most commonly used PET radiotracer for cancer has been [F-18] fluorodeoxyglucose (FDG-PET). Neoplastic cells exploit anaerobic glycolysis more than surrounding normal tissues, FDG is converted within these cells to 2-deoxyglucose-6-phosphate, which cannot be utilized by the glycolytic pathway and becomes trapped within the cells.

Currently, over 800 combined PET/CT scanners are installed in medical institutions worldwide. Many of them are for the diagnosis and staging of malignant disease and increasingly for monitoring of the response to therapy. **(5)**

PET/CT is more accurate in tumor staging than PET or CT alone and even more than PET and CT images viewed side by side. **(6)**

Comparison of PET/CT with PET alone in various malignancies found respective increases in sensitivity, specificity, and accuracy from 90%, 93%, and 91% for PET to 98%, 99%, and 98% for PET/CT, with a decrease of approximately 50% in equivocal lesions for PET/CT. **(5)**

FDG PET has become an accepted and widely used imaging modality for the staging and follow-up of head and neck cancer. In comparison with anatomic imaging modalities, PET is more accurate for the detection of neck nodal metastases, and recurrent disease in patients with head and neck cancer. **(7)**

Combined PET-CT is a unique imaging modality that permits anatomic (CT) and functional (PET) scans to be acquired with perfect or near perfect coregistration using a single device. Combined PET-CT offers additional information that cannot be obtained with PET or CT alone. In particular, PET-CT facilitates the interpretation of FDG uptake in the head and neck, an area of particular difficulty due to dense and complex anatomic structures. **(8)**

Positron emission tomography (PET) with 2-[fluorine-18] fluoro-2-deoxy-d-glucose (FDG) has been effective for the diagnosis, staging, and restaging of malignancies of the head and neck region. PET-CT facilitates the interpretation of FDG uptake in the head and neck, an area that is characterized by dense and complex anatomic structures. **(8)**

In patients with head and neck cancer, PET with [F-18] fluorodeoxyglucose (FDG) is both more sensitive and specific than CT or MR for detection of both primary and recurrent neoplasm. **(9)**

PET/CT is useful in head and neck tumors for local-regional staging, identification of distant metastases, and therapy monitoring. **(4)**

Combined PET-CT helps in preventing the misinterpretation of FDG PET findings in patients with head and neck cancer. This is particularly true in the treated neck where distortion of normal tissue planes makes detection of early disease recurrence difficult with conventional computed tomography (CT) and magnetic resonance imaging. Superior localization of FDG uptake with this technique can improve diagnostic accuracy and help to avoid interpretative pitfalls. **(10)**

The use of PET/CT fusion imaging in patients with head and neck cancer improves the anatomic localization of abnormalities identified on PET images alone. More important, this improvement in anatomic localization was associated with a 53% decrease in the number of equivocal PET findings, while a high diagnostic accuracy was maintained. PET/CT findings were instrumental for a change in patient care in 18% of patients. **(11)**

There is incremental value of PET/CT images over PET and CT images interpreted separately. PET/CT has an overall sensitivity of 98%, specificity of 92%, and accuracy of 94% for the evaluation of patients known to have or suspected of having squamous cell carcinoma of the head and neck. **(5)**

Several clinical studies suggest that highly elevated baseline FDG uptake by primary (HNSCC), quantified as the standardized uptake value (SUV), predicts for advanced clinical stage and worse prognosis, including inferior local control, disease free survival, and overall survival. **(12-14)**

After radiation and/or chemotherapy, changes in tumor metabolism precede morphologic changes. Similarly, after radical surgery or radiation therapy for head and neck malignancies, normal tissue planes are altered substantially. Therefore, CT and MR imaging have relatively poor specificity in the assessment of residual or recurrent disease following radical therapy. Positron emission tomography (PET), on the other hand, helps evaluate tumor metabolism, and the information obtained is essentially independent of tumor location and lesion size. For these reasons, PET (FDG) has been used successfully for the assessment of tumor aggressiveness, for staging of nodal disease in the neck, for treatment evaluation, and for detection of recurrent disease in patients with head and neck cancer. Unfortunately, the lack of anatomic detail remains a major limitation of PET as it is currently used**.** Combined PET/CT is a recent imaging technique that permits almost synchronous image acquisition and exact co-registration of anatomic and metabolic data sets. This technique improves the anatomic localization of PET abnormalities and reduces the number of equivocal PET interpretations. PET/CT is more accurate than PET alone in the detection and anatomic localization of head and neck cancer and has the clear potential to affect patient care. **(7)**

Aim of Work

Objective:

The objective is to study the role of PET/CT in the initial diagnosis and staging of patients with head and neck tumors, the overall clinical outcomes, evaluation of treatment response and detection of recurrence.

Comparing the PET/CT with the contrast enhanced CT, using the following endpoints for treatment response/follow up group (a) histopathologic findings; (b) obvious clinical findings such as fungating carcinoma; (c) the combination of negative clinical findings, negative findings of other imaging studies, or negative follow-up findings; (d) resolution of apparent abnormalities at subsequent PET/CT studies without intervening therapy together with negative clinical follow-up findings; and (e) the combination of positive clinical findings at the time of PET/CT and resolution of the tumor after chemotherapy or radiation therapy.

As for the initial staging group using the following endpoints:

(1) To assess the diagnostic impact of FDG-PET/CT, i.e. the diagnostic gain compared with pre-treatment morphological imaging.
(2) To determine the therapeutic impact of FDG-PET/CT, i.e. in terms of changes to the initial treatment plan or modifications to radiotherapy.

Study population:

Patients of all ages, with tumors of the pharynx, larynx, salivary glands, and sinuses, with either pre, post treatment PET/CT or both and CT examination of the head and neck.

Sample size:

69 patients.

Keywords:

PET/CT, Head and Neck tumors, Radiotherapy