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Use of PET in Head and Neck Cancers

Review

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Abstract

Head and neck cancer imaging is especially necessary for staging. Computed tomography and magnetic resonance imaging are the techniques frequently used for this purpose. These methods are valuable for displaying detailed anatomical structures; however, they may be inadequate for making the distinction between recurrence, residual tumor, fibrosis, and normal tissues with an altered anatomy after treatments such as surgery, radiotherapy, and chemotherapy and for the detection of metastases. From this point, positron emission tomography may be a promising imaging method. Scanning the entire body with a single method is an important advantage of positron emission tomography. It may be useful in the detection of synchronous tumors, which are a serious problem in head and neck cancers. Positron emission tomography may provide additional contribution for neck metastases, where the primary site is unknown and is undetectable by other imaging techniques.

Keywords: Head and neck cancer, positron emission tomography, staging, cancer

Introduction

Head and neck cancers (HNC) comprise larynx, esophagus, nasal cavity, oral cavity, paranasal sinuses, salivary glands and thyroid gland neoplasms. The cancers of these regions may impair communication, nutrition and aesthetics due to its effects on swallowing, speaking, respiration and outer view. Formation of HNCs frequently on mucosal surfaces enables detection of these diseases by direct examination and endoscopic examination methods. The imaging methods in HNCs are important in staging of the disease (1). The vital organ and structures in head and neck region are in close neighborhood to each other. So setting the margins of the disease is important. The data obtained are also necessary to inform the patient with regard to direction of the treatment and the functions that may be lost.

Especially computed tomography (CT) and magnetic resonance imaging (MRI) are the commonly used imaging methods. These methods are valuable for detailed imaging of anatomical structures however they may be insufficient in differentiating the changes after treatments of surgery, radiotherapy (RT) and chemotherapy (CT) (2-4). There may be difficulties in differentiating relapse, residue tumor, fibrosis and normal tissues anatomies of which underwent a change and restaging patients for whom rescue therapy is planned. There may arise the necessity to include many parts of the body under the area of investigation in detecting regional and distant metastases gained importance especially in advanced HNCs. This may lead to the rise of radiation dose the patient takes, waste of time and high cost. Moreover CT, MRI and other imaging methods may be inadequate for some patients in detecting primary region of neck metastases (5). The mentioned difficulties led to seeking goal-directed imaging methods that can differentiate infected tissue from the normal tissue. In this respect positron emission tomography (PET) is a promising imaging method that can fill the gap in HNCs (6, 7).

In the recent years many studies about the use of PET in HNCs have been published. It is not yet possible to mention about accumulation of knowledge to put forward the indications of the PET use for every head and neck region cancer. Moreover not having been formed a consensus about the general indications of the use of PET in HNCs led to the need to review the evidences about the issue. In this review it was aimed to discuss PET use in HNCs under subheadings and to obtain general implications about the issue in line of this knowledge.

Clinic and Research Effects

General Features of PET

Positron emission tomography provides detailed anatomical information and also physiological and biochemical data different from CT and MRI. The distribution of the radioactive chemical agent, injected intravenously, having the biological sub-

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stance feature in the body is measured by the detectors placed around the patient. Most frequently used biological radioactive chemical for this purpose is 18F fluoro-2-deoxy-2-glucose (FDG). Other radioactive chemical substances may also be used apart from this. Depending on the agent selected, data reflecting blood flow, ischemia, DNA metabolism, glucose metabolism, protein synthesis, amino acid metabolism and the state of receptor can be obtained. However FDG is preferred due to its ease of use and relatively long half life (110 minutes)(1). Since glucose metabolism of the neoplastic cells is more active, increased FDG involvement is observed in these cells. However increased glucose metabolism is not specific to malign cells; PET may give false positive results in case it is seen in benign tumors, inflammatory or infectious lesions and normal tissues (2). For instance FDG involvement is very high in sinonasal inflammation and this limits the use of PET especially in paranasal sinus tumors. FDG involvement increases physiologically during muscle contractions in the neck and this can be confused with tumor involvement (8). Moreover in some cases expected glucose metabolism may not be seen in malign cells and this may lead to false negative result.

SUV (standardized uptake value), a quantitative value, is used while interpreting positron emission tomography. This value indicates the radioactive substance concentration involved in the same period. SUV can be used to differentiate increased involvement due to benign reasons and malign tissues or to evaluate response to the treatment.

Not being able to detect the localization clearly is an important disadvantage of PET method. In order to overcome this problem, superior imaging methods anatomically such as CT and MRI are combined with PET. Nowadays PET-CT has almost become a standard combination (3, 4). Nevertheless faults are still experienced depending on physiological or involuntary movements (8). Low spatial resolution is another disadvantage of PET. Therefore microscopic disease cannot be detected with PET (1, 3).

Positron emission tomography-CT has high sensitivity, specifity and negative predictive value but low positive predictive value. In other words PET-CT's resulting negative may not necessitate further research but its being positive may necessitate the use of other imaging methods or histological verification (5, 9-11).

PET Use for Diagnosis

No imaging method seems to be superior than endoscopic examination methods for detection of mucosal surface lesions in head and neck cancers. It is not possible to mention that PET is more successful when compared to CT or MRI in detection of submucosal lesions. Therefore the use of PET as the first method to be applied in diagnosis stage is not appropriate. However, PET is very valuable in detection of neck metastases primaries of which cannot be detected by other imaging methods and detection of neck metastases is one of the most recommended areas of use of PET in the literature (5, 7, 12, 13). Karapolat et al. have suggested that PET is an imaging method, having high reliability, that can be used successfully for primary focus investigation in cervical lymph node metastases primaries of which are unknown and in detection of distant metastases (7). There are some advantages of the application of PET before panendoscopy in the patients having neck metastases primaries of which have not been detected yet, although other known imaging methods have been used. In these patients primary lesion can be detected before panendoscopy by application of PET and goal directed biopsies may be conducted. Moreover obtaining false positive results in PET scans conducted a little while after panendoscopy and blind biopsies have been averted.

PET Use in Staging

Occult metastases are very important problems in staging HNCs. PET can provide additional beneficial information in staging when compared with other imaging methods; however it does not seem to take the place of CT and MRI (14). PET's use for N0 patients to evaluate lymph node metastases is not recommended since they cannot detect microscopic disease. It was reported not to provide additional benefit for N+ patients (15, 16). PET should not be the key determinant in making a decision for neck treatment (17).It is more appropriate to benefit primarily from the methods such as CT and MRI which can indicate the anatomical localization of the primary tumor simultaneously for the purpose of nodal staging. However in case there is an inconsistency in these treatment methods and the additional data obtained change the treatment plan remarkably, PET can be preferred for nodal staging (18). PET is generally very valuable in evaluation of distant metastases (9, 19). PET use is recommended especially for distant metastasis in medium/high risk (advanced HNCs, early stage HNCs having unknown symptoms) patients in staging. There are studies indicating that PET is an appropriate method for staging of nasopharyngeal cancers (NPC) (10). It is suggested that PET is more reliable than scintigraphy in indicating NPC's bone metastases (21). PET has been recommended for evaluating regional and distant metastases in neck paragangliomas having malignity suspicion (22). It is considered that PET overstates the disease in malignant lymphoma and may aggravate treatment unnecessarily (23). Being able to conduct whole body scan by one method is a very important advantage of PET. Moreover it may also make it possible to diagnose synchronous tumors which are important problems in HNCs (9). Nevertheless it should be kept in mind that there may be wrong results. Negative result of PET-CT may direct the clinician to monitoring decision more reliably. Although PET has important advantages in detection of metastases, the use of this method primarily in pretreatment evaluation of the detection of metastases does not seem appropriate.

PET Use in Planning and Monitoring the Treatment

The data obtained with positron emission tomography may be beneficial in determining radiotherapy regions (20). Comparative SUV before and after the treatment may provide evaluation

of response to the treatment (24). PET has an important place in evaluation of especially the patients suspected of having relapse (25, 26). Koç et al. in their studies have concluded that PET is effective in detection of relapse, residue, and metastatic tumors (6). It may not be possible to differentiate recurrent disease, fibrosis and normal tissues, anatomies of which underwent a change by CT or MRI. In such cases and especially while planning rescue treatment, there may be serious difficulties in restaging of the disease. In this patient group, the data that will be obtained through PET are very important for investigating diseases in the regions which cannot be evaluated clinically or can be evaluated difficultly (14, 18). It has been reported that negative results of PET-CT for lesions bigger than 8 mm is highly reliable (27). Considering that inflammation associated with surgery or RT can cause wrong positive results, PET is recommended to be performed at least three months after the completion of treatment (3, 28).

Further tendencies for positron emission tomography-CT can include the use of PET-MR more frequently, introduction of new ligands into clinical practice instead of FDG, and formation of guidelines for optimizing the use of this technique.

Conclusion

In the review of literature, it is seen that PET has some features owing to which it is superior to other imaging techniques in HNCs. The use of PET is recommended for the following conditions:

- In neck metastases, the primary of which cannot be detected through other imaging techniques,
- In staging risky tumors for distant metastasis, especially advanced stage HNCs, and investigating the presence of synchronous tumor,
- In determining recurrent disease and re-staging the disease while planning rescue treatment,
- In the presence of inconsistency in other imaging techniques and in the possibility of an apparent change in the treatment plan due to additional data that can be obtained.

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