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The use of positron emission tomography and computed tomography in the assessment of trismus associated with head and neck malignancy

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Abstract

The assessment of head and neck cancer has traditionally involved clinical examination and anatomical imaging by computed tomography (CT) or magnetic resonance imaging (MRI). We present a case where a problem of clinical confusion and inconclusive radiology was resolved by the use of positron emission tomography (PET) coregistered with CT.

Key words: Trimus; Tomography, emission-computed

Introduction

Examination of the oral cavity can be extremely difficult when a patient presents with trismus. The clinician is faced with the difficulty of identifying the disease process concerned whilst being unable to clinically assess the area close to the pterygoid muscles. Restriction of mouth opening is often regarded as a sinister sign in those patients with known malignant disease as this sign indicates tumour infiltration of the pterygoid muscles or mechanical obstruction of the mandibular coronoid process or the condylar process (Beekhuis and Harrington, 1965).

Imaging by CT or MR has improved the accuracy of assessment of head and neck cancer, particularly in those areas where the tumour cannot easily be examined clinically. The appreciation of the relationship of vital structures to the pathology allows a better selection of treatment modality. Trismus is a particular situation where imaging is vital to make a full assessment of disease extent and in this context both CT and MR are valuable diagnostic aids (Ciacchella and Higgins, 1990; Ichimura and Tanaka, 1993). We present a case where CT imaging and PET provided the vital information necessary for planning treatment.

Case report

A 37-year-old male Nigerian patient attended clinic with a four-month history of left-sided facial pain. He had undergone removal of his upper left wisdom tooth two months previously. He subsequently developed a lump in the neck which limited neck movements. By the time he presented he had pain in the left eye and had developed trismus. On examination a 6 × 6 cm mass was found in the left submandibular triangle. The left eye was proptosed and an ulcer was seen on the left buccal mucosa. Examination of the retromolar trigone was limited by trismus with mouth opening of only 1 mm. Biopsy of the ulcer revealed squamous cell carcinoma. The proptosis was thought to be due to hyperthyroidism on the basis of thyroid function tests. Pre-operative investigations included imaging with CT and PET scans. Haematological testing detected exposure to Epstein-Barr virus but was negative for hepatitis B and human immunodeficiency virus (HIV).

Surgery was performed three weeks after presentation and consisted of a left neck dissection, left hemimandibulectomy, partial maxillectomy with reconstruction by pectoralis major myocutaneous flap. The patient was referred for post-operative radiotherapy. Histological analysis confirmed the presence of squamous cell carcinoma and that excision was complete.

Imaging

CT scan.

A CT scan had been performed just prior to the PET study. Axial views in 5 mm sections were obtained from the skull base to the sternovascular joints during infusion of intravenous contrast (Figure 1). This investigation was reported as showing extensive confluent adenopathy on the left side extending from the level of the parotid to the level of the thyroid cartilage. A number of the nodes showed relatively low density centres.

PET scan.

PET imaging was performed on a Siemans ECAT 951/31R scanner. A 10 minute transmission study in two bed positions, of the head and neck, were performed prior to injection of 18-F fluorodeoxyglucose (FDG). Base line blood glucose was 5.1 mmol/l. Static PET images of the body and localized views of the head and neck were acquired 45 minutes after intravenous injection of 365 MBq of FDG. Attentuation correction and quantitation was performed on localized head and neck views. Standardized uptake values (SUV) were calculated from regions of interest over the hottest pixel in each lesion with

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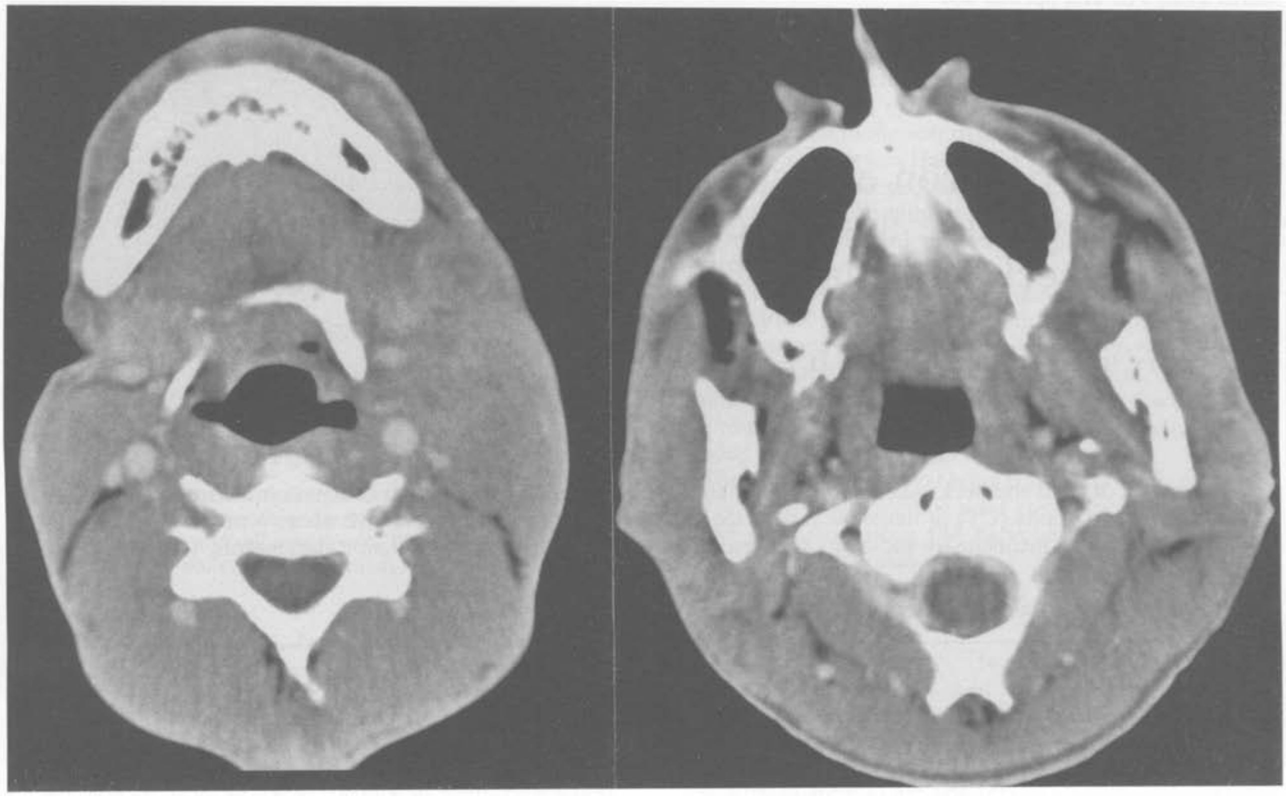

FIG. 1
CT transaxial slices showing extensive left cervical adenopathy (left).

correction for partial volume and blood glucose level. An intense focus of increased FDG uptake was noted in the anterior part of the masticator space (SUV = 4.4). Two further areas of uptake were noted in the region of the jugulodigastric lymph node (SUV = 6.3) and the palatopterygoid fossa (Figure 2).

Coregistration scan

Image coregistration of the PET study to the CT scan was performed using internal anatomical landmarks (Hill *et al.*, 1991; Wong *et al.*, 1996). The registered PET data were superimposed on the transaxial CT slices and reported jointly by a nuclear physician and a radiologist (Figure 3). The fused image identified the site and extent of the primary cancer and confirmed the presence of neck metastases.

The CT scans showed replacement of fat by soft tissue postero-lateral to the antrum in the anterior part of the masticator space and this area also showed high uptake on PET. It was not possible to assess whether the tumour was resectable and raised the possibility of a major exploratory procedure. PET scans identified the presence of malignant disease and the coregistration with CT localized disease to the retromolar region with no involvement of the pterygoid region as fat planes were seen to be preserved on CT and there was no uptake on the PET scan. On the

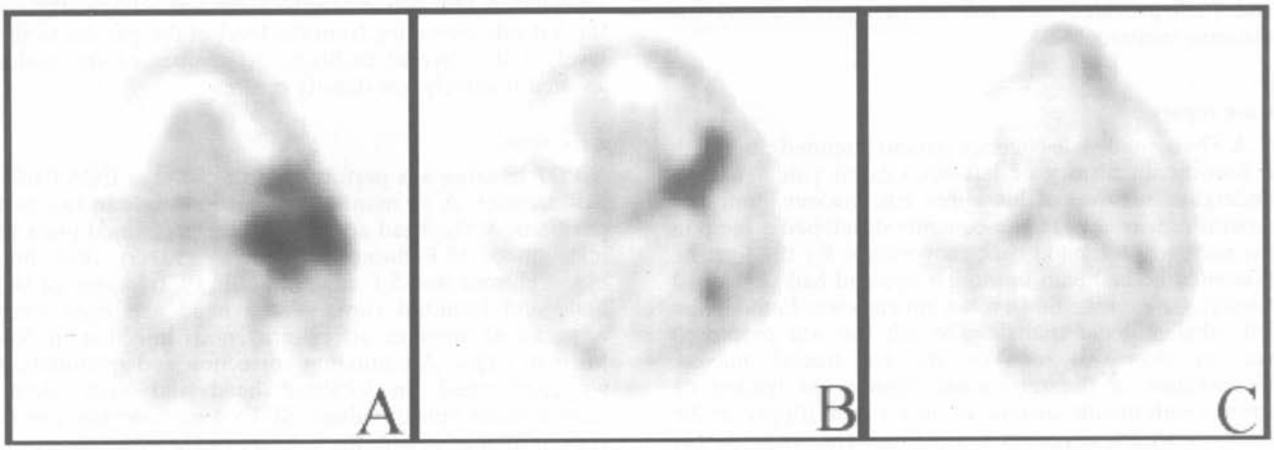

FIG. 2
18-F FDG PET transaxial slices demonstrating marked abnormal FDG uptake in the left jugulodigastric lymph nodes (A) and in the region of the maxillary antrum (B). (C) defines the upper limit of the disease.

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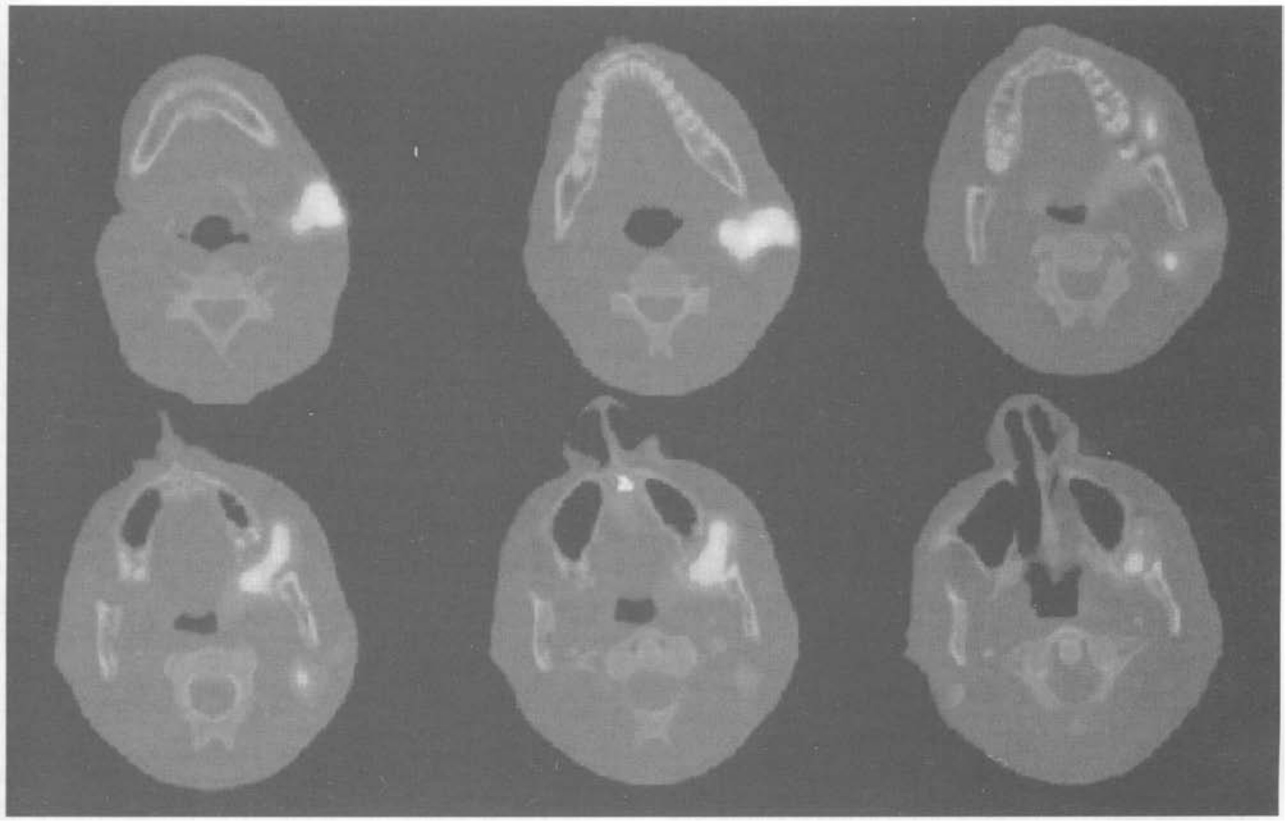

FIG. 3

Co-registered PET to CT scan confirming malignant disease in left cervical adenopathy and further disease posterolateral to the maxillary antrum extending into the posterior nasopharynx.

basis of this imaging study the tumour was considered resectable.

Discussion

Trismus is defined as prolonged, tetanic spasm of the jaw muscles by which normal mouth opening is restricted (Tveteras and Kristensen, 1986). The causes of trismus are shown in Table I (Luyk and Steinberg, 1990). Trimus due to malignant disease results from mechanical obstruction of mandibular movement due to the bulk of tumour or infiltration of disease into the pterygoid muscles. Trismus may also result from fibrosis of the muscles secondary to radiotherapy (Engelmier and King, 1983; Parsons, 1984). The fibrosis is normally of gradual onset but is progressive as the mucositis subsides.

Anatomical imaging using CT or MR is routinely performed to delineate the extent of primary or metastatic disease in the head and neck. When fascial planes have been disrupted following surgery or radiotherapy, anatomical techniques cannot be relied upon to discriminate between fibrosis and malignancy. In a patient with trismus the additional difficulty in making a clinical assessment adds to the problem.

Ichimura and Tanaka (1993) noted that CT was not helpful during the onset stage of trismus due to malignant disease as reflex muscle spasm or micro-invasion into the pterygoid muscles was too small to be seen. The use of MR in assessing inflammation of the pterygoid muscles has been described by Ciacchella and Higgins (1990). MR imaging can show an increase in the size of the muscles and an increased signal on the T2-weighted image due to increased water content in an inflamed tissue. The authors make no mention of how MR could differentiate between inflammation and malignancy or how accurate the investigation would be if the tissue planes were disrupted.

Positron emission tomography is a relatively new technique in the investigation of head and neck malignancy. PET scanning makes use of radio nuclides that decay by the emission of positively charged particles – positrons. Positrons travel short distances in tissues before combining with a negatively charged electron, converting mass into energy and releasing two high energy photons or

TABLE I

CAUSES OF TRISMUS

Congenital	–	Hemifacial microsomia
		Fibrodysplasia ossificans progressiva
		Birth injury
Traumatic		
Neoplastic	–	benign
		malignant
Neuromuscular	–	Parkinson's disease
Acute reactive	–	Septic arthritis
		Tetanus
		Peritonsillar infection
		Mumps
		Osteomyelitis of the mandible
Chronic reactive	–	TMJ ankylosis
		Degenerative joint disease
		Rheumatoid arthritis
		Radiation therapy
		Systemic sclerosis
		Ankylosing spondylitis
Psychogenic		
Drug-induced	–	facial dyskinesia
		Strychnine poisoning

From Luyk and Steinberg (1990); this list provides examples and cannot be considered exhaustive.

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gamma rays at approximately 180 degrees to each other. The simultaneous detection of these photons by opposing detectors is then used to reconstruct a three dimensional image of these events. FDG is a glucose analogue that is transported into the cell without being further metabolized in significant amounts during the examination time after the initial phosphorylation. Cancer cells have increased glucose metabolism and the FDG can deliver quantitative information about the glucose metabolism of the tumour (Hawkins *et al.*, 1991).

A number of studies have been published demonstrating that PET-FDG can detect primary and metastatic squamous cell carcinoma in the region of the head and neck (Bailet *et al.*, 1992; Jabour *et al.*, 1993; Greven *et al.*, 1994). Although the accuracy of detection of metastatic disease is not a sigificant improvement on anatomical techniques, the assessment of primary disease and the detection of recurrent disease has proven to be very reliable (Greven *et al.*, 1994).

Muscle tension or exercise just prior to or during the uptake period can result in marked FDG uptake within skeletal muscles (Barrington and Maisey, 1996). It is interesting to note that there was no increased uptake in the muscles involved in trismus in this patient unlike tense or active muscles. The present study indicates that infiltration of the temporalis muscle in the region of the coronoid process can induce profound trismus without involvement of the pterygoid muscles within the depth of the infratemporal fossa.

This case demonstrates the benefits of image registration in localization of PET abnormalities, allowing the clinician to plan treatment more effectively. The head and neck unit and clinical PET centre at Guy's and St Thomas' have been using this technique to image tumours in the head and neck and have reported on the accuracy elsewhere (Wong *et al.*, 1996). In the reported case, initial PET findings demonstrated more extensive disease than expected from the CT and clinical examination. Whilst PET-FDG imaging provided an excellent target to background ratio allowing easy identification of abnormalities, the lack of anatomical landmarks makes accurate localization difficult. Coregistration enhances the role of PET in delineating tumours in hidden areas of the head and neck and may have profound effects on treatment planning.

Conclusion

Positron emission tomography provides a valuable new method of assessment of squamous cell carcinoma in the head and neck. Colocalization of the images with CT or MR give a better appreciation of the relationship between the area of disease and normal structures. This is particularly important when one considers the complex anatomy in this region.

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