A Novel Scintigraphic Approach for the Detection and Evaluation of Bronchopulmonary Aspiration

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Introduction

Bronchopulmonary aspiration (BPA) is a cause of significant morbidity in the dysphagic patient: aspiration of food or drink may result in aspiration pneumonitis, bronchospasm, bronchopneumonia or life-threatening sepsis.[1,2] An accurate and early diagnosis leads to appropriate treatment with oral restriction and alternate feeding as necessary.

We report on a noncompliant patient in whom pulmonary ventilation scintigraphy with Kr-81m proved beneficial in the evaluation of BPA.

Case Report

A 55-year-old man with a history of alcohol abuse, was initially treated with radiotherapy and chemotherapy for carcinoma of the larynx involving the piriform fossa. Treatment was complicated by cavitating disease at the apices of the lungs, which was treated with six months of anti-tuberculous chemotherapy. He subsequently developed periodic mild dysphagia with the sensation of food sticking at the level of the xiphisternum, and lost 30 kg in weight over the following two years.

Three years later, the patient was admitted with an epileptic seizure, when a CT brain showed generalized cerebral atrophy, and a barium swallow revealed laryngeal spill associated with poor muscular coordination and diminished oesophageal peristalsis. Clinical examination revealed extensive fibrosis of the neck without lymphadenopathy and the chest examination was consistent with upper-zone pulmonary fibrosis. The patient was discharged from the ward and was able to swallow soft-consistency meals. His GP successfully treated him with oral antibiotics for occasional bronchitic chest infections.

The patient was readmitted after three years with a sudden onset of right sided hemiparesis and upper motor neurone facial palsy. He was found to be dysphonic (reportedly long-standing), dysarthric and dysphagic. CT showed an area of haemorrhage centred on the left lentiform nucleus with mild compression of the left lateral ventricle and cerebral atrophic changes. The hemiparesis improved over the next few days.

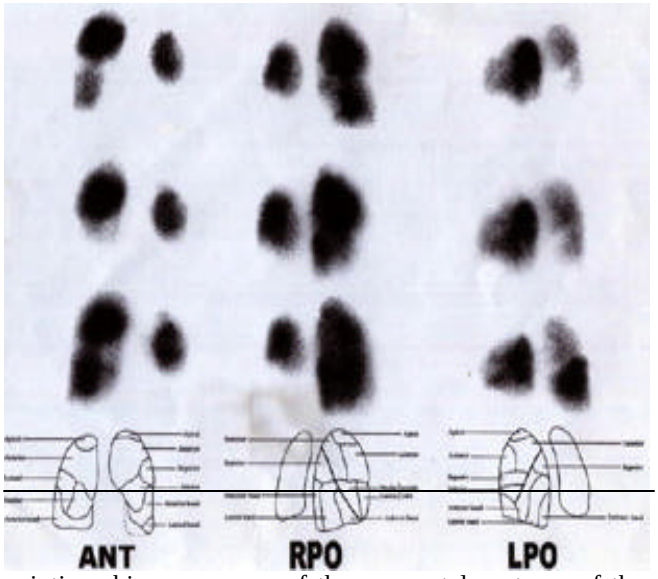
Bedside assessment of his dysphagia indicated that oral intake of any consistency was unsafe. Videofluoroscopy of a modified barium swallow showed no laryngeal elevation. There was laryngeal penetration of food and liquids during swallowing, with a significant pharyngeal residue. This suggested reduced pharyngeal clearing, presumably secondary to the cerebrovascular accident in combination with tissue fibrosis following previous radiotherapy to the larynx. There was no consistent cough reflex to clear laryngeal penetration. Follow-up laryngoscopy revealed an oedematous larynx, mobile vocal cords and no sign of tumour recurrence. As oral nutrition was considered hazardous, a gastrostomy was performed. The patient was fed and hydrated exclusively via the gastrostomy tube and was discharged home on this regime.

However, the patient showed poor compliance and about two months following discharge, started supplementing his gastrostomy feeds with regular oral meals. Outpatient clinical dysphagia assessment at three months after discharge, indicated that although his swallowing had improved in that his larynx could elevate slightly with all consistencies of intake, his voice post-swallow was bubbly, indicating probable aspiration. The patient was considered clinically at a high risk for bronchopulmonary aspiration (BPA) and was advised to confine to gastrostomy feeding, which the patient found too restrictive and continued oral intakes despite the informed risk of BPA. The patient was referred to the nuclear medicine department for further investigation.

Scintigraphy

Pulmonary ventilation scanning was performed using Kr-81m eluted from a 10 mCi Rb-81 generator. A standard ventilation protocol was adopted. Kr-81m was administered via a face mask during tidal breathing and images of the regional ventilation were acquired in multiple projections using a large field-of-view gamma camera (400T Maxicamera, International General Electric Co., UK) fitted with a general-purpose collimator and coupled to a dedicated computer (PDP-11, Nuclear Diagnostics, UK). The computer was set to 190 keV energy peak for Kr-81m with a 20% window. Static 400 K-count images were acquired in 128 x 128 matrix, with simultaneous acquisition of analogue images.

Three sets of ventilation scans were performed (Figure), including an initial baseline scan (top row), a postprandial scan performed immediately following oral ingestion of 120 ml of plain yogurt (second row) followed by a delayed scan after sixty minutes (third row). For ease of interpretation, the bottom row of Figure outlines the



scintigraphic appearance of the segmental anatomy of the lungs for the three different views obtained.

The baseline lung scan showed loss of ventilation to the lower lobe of the left lung with a subsegmental defect in its antero-apical segment. There was no significant change in ventilation to the left lung on both the early and the delayed postprandial ventilation images. The baseline ventilation images of the right lung showed loss of ventilation to the posterior basal segment with a horizontal band of reduced ventilation seen in the mid-zone of the lung. The early postprandial image of the right lung showed reduced ventilation in the middle lobe and in the lateral and anterior basal segments, but ventilation to the right posterior basal segment was restored. The delayed postprandial ventilation scan showed return of ventilation to the right lower and middle lobes.

Discussion

Modified Barium Swallow (MBS) performed under videofluoroscopy or cineradiography is a common method of BPA assessment. The technique involves ingestion of various consistency foods mixed with barium. However, the MBS test has certain limitations: the surrogate food challenges used, are not representative of the patients' normal diet, both in amount and type; trace amounts of aspiration may be missed in the session; and late aspiration following completion of the study will not be documented.[3,4] It has been asserted that patients who aspirate more than 10% of their oral intake are at risk of aspiration pneumonia.[5] Since the MBS technique cannot objectively quantify the aspirated amount[3], it can therefore be surmised that on the basis of the MBS test result, a sub-population of aspirators (in whom the amount of the aspirate is insufficient to cause significant ventilation compromise) may have their oral intake curtailed unnecessarily.

In an attempt to overcome the inherent limitations of the MBS test, scintigraphic techniques for evaluating BPA have been introduced in the recent years.[4,6,7] The reported radionuclide techniques detect the amount and evaluate the rate of transit of activity through the oral, pharyngeal and bronchopulmonary regions, following ingestion of a radioactive meal. The radionuclide techniques allow quantitation of the amount aspirated, but are unhelpful in the precise localisation of the site of BPA, nor do these studies provide any information on the significance of BPA on the pulmonary function, i.e. the effect of airway obstruction on regional pulmonary ventilation.

In the present case, the reported scintigraphic techniques of BPA evaluation utilising radioactive meals were considered unsuitable due to a high risk of radioactive contamination because of the patient's known impairment of swallowing, pharyngeal retention of food, repeated retching and reflux. Therefore, a new approach using a non-radioactive meal was devised to establish the presence and determine the extent of BPA. The patient underwent Kr-81m inhalation ventilation imaging, a scintigraphic technique that involves minimal radiation exposure and is easily performed in most nuclear medicine departments.

Kr-81m ventilation lung scans of this patient at a high risk of BPA due to impairment of pharyngeal and laryngeal reflexes, indirectly but unequivocally established the diagnosis of BPA by demonstrating fresh pulmonary ventilation defects in the patient's right lung following ingestion of the non-radioactive meal. The segmental ventilation defect in the right posterior basal segment on the baseline scan, which resolved on the early postprandial scan was supposedly secondary to a previous episode of BPA at this site, and was consistent with the transient nature of the BPA episode reflecting the adequacy of bronchopulmonary clearance. The inconstant distribution of the aspirated material may be posture-dependent. Also, the postprandial loss of ventilation to the right middle lobe and parts of the right lower lobe, followed by restoration of normal ventilation an hour later, showed the efficacy of the physiological pulmonary clearance. However, the fixed ventilation defects noted in the lower lobe of the patient's left lung on all three sets of scans were presumably due to previous episodes (perhaps recurrent) of BPA resulting in permanent ventilation compromise in this region. Thus, the ventilation study revealed both fixed and transient pulmonary ventilation abnormalities, probably depicting the temporal sequence of events. On the basis of our observation we conjecture that patients demonstrating transient ventilation changes may, in spite of documented BPA, might be considered for an oral intake. This hypothesis merits further exploration and validation.

This technique delineated both the extent and the duration of ventilation compromise secondary to BPA and allowed assessment of the physiological significance of BPA. Further research may establish the clinical value of this approach for evaluating BPA in patients with a range of swallowing disorders.

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