
Detection of Pulmonary Aspiration in Children by Radionuclide "Salivagram"

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The radionuclide "salivagram" was introduced to document the aspiration of oral secretions in patients who are at risk. Approximately one-third of patients studied had positive tests. A positive study does not necessarily imply that patients are at risk for aspiration after gastroesophageal reflux. However, sequential images of the lung fields after the oral radioactivity has cleared may be a sensitive technique for detecting aspiration in infants and children following reflux.

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The aspiration of saliva, food, or gastric contents can result in a severe pneumonitis or bronchopneumonitis. The damage results from bacteria in oral secretions, or the chemical content of aspirated material, and may be life threatening. Aspiration pneumonia occurs with neurologic dysfunction, gastroesophageal reflux, or following surgery to the upper airway or digestive tract. The diagnosis is usually made by barium swallow. Radionuclide techniques have been introduced in an attempt to increase the sensitivity of detection. These depend on the monitoring of a radiolabeled liquid meal, followed by delayed imaging up to 24 hr (1). The detection of aspiration in children referred for gastroesophageal reflux studies using milk with tracer amounts of technetium-99m (^{99m}Tc) sulfur colloid has been disappointing (2), though there are reports of some success (3,4). A recent study in adult patients employing 20 ml of water containing 2.5 mCi [^{99m}Tc]sulfur colloid was found to be effective in detecting aspiration, and to be more sensitive than videofluoroscopy (5). In an attempt to improve the detection rate in infants and children the technique has been modified, and is termed a "salivagram" (6). This relies on the introduction of 200-300 μCi of [^{99m}Tc]sulfur colloid in a volume < 100 μl onto the tongue. This report describes the results of the salivagram in 27 patients thought to be at risk for aspiration.

MATERIALS AND METHODS

Twenty-seven patients were studied, 14 males and 13 females. They ranged in age from 1 mo to 15 yr (mean 5.6 yr). Twenty-one suffered from recurrent pulmonary infections, and chronic aspiration was suspected. In the remaining six patients, functional or anatomic abnormalities were thought to predispose to the aspiration of saliva. Psychomotor retardation was evident in 20 patients, 11 having cerebral palsy. One child with a brain tumor developed bulbar dysfunction, and another had laryngeal incompetence and difficulty with swallowing following the surgical repair of a cleft lip and palate. There were four former premature infants, one of whom had developmental delay, and one patient with intermittent pylorospasm. Four patients had tracheostomies at the time of the study.

Fourteen patients were being fed orally, all having some evidence of feeding difficulty. Three were fed by nasogastric tube and ten through gastrostomy tubes. Nissen fundoplications had been performed on five infants because of severe gastroesophageal reflux and recurrent pneumonia.

Technetium-99m sulfur colloid, ~300 μCi in < 100 μl , was placed on the tongue and allowed to mix with the oral secretions. Patients were placed in the supine position above the gamma camera, fitted with a low-energy, all purpose collimator taking care to include both the mouth and stomach in the field of view. Posterior imaging allowed for access should suctioning be necessary. Analog images, each 60 sec in duration and containing ~300-500 thousand counts, were obtained at 5-min intervals for 1 hr, using a high intensity setting on the formatter. More recently sequential 60-sec images were acquired for 1 hr using a digital camera. Simultaneous computer images were acquired at 30-sec intervals in 64 \times 64 byte mode, for later dynamic playback with contrast enhancement.

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RESULTS

Twenty studies were negative for aspiration (Fig. 1). Of these, 14 had milk scans, with six being positive for reflux but negative for aspiration (three were fed orally, two by gastrostomy, and one by nasogastric tube). Three barium swallows and a pH probe study were negative for reflux or aspiration in four patients, one of whom had a positive salivagram.

There were seven positive studies, all showing bilateral aspiration to at least the level of the tracheal bifurcation (Fig. 2). Six of these had recurrent pneumonia, the remaining patient having a brain tumor and bulbar dysfunction. Three of these patients also underwent radionuclide reflux studies (milk scan), two being fed by nasogastric tube and one through a gastrostomy. Only one showed evidence of reflux, but aspiration was not detected. To evaluate the impact of these studies on the clinical management of these patients, the charts were reviewed. In the negative group no action was taken in 17 cases. Two patients with gastroesophageal reflux were placed on Reglan. In another the oral feedings were changed to nasogastric at night only, since episodes of coughing were more severe then. Positive scans resulted in four patients being changed to nasogastric feeding only, and gastrostomies were performed in two. In the remaining patient the symptoms were severe, and the recurrent pneumonia was thought to be life threatening, so that tracheal diversion was recommended.

DISCUSSION

Although this is a retrospective study, and no attempt has been made to compare the sensitivity for the detection of pulmonary aspiration with other techniques, it appears that the radionuclide salivagram demonstrates aspiration in a relatively high percentage of cases. Considering the patients with documented recurrent pneumonia, there were six positive studies in 21 patients, or 29%. It is true that the patients are highly selected, but in equivalent patients we and others have found a low positive rate for pulmonary aspiration using the standard radionuclide reflux study (2). The detection rate compares with that reported by Boonyapara et al., using a technique not very different from the reflux study. Why they had greater success in detecting aspiration is not clear, even though their series only included patients with respiratory disease who were thought to be aspirating (3). In another report by Orellana et al., using a radionuclide technique in children, the detection rate was relatively high (30%) (4). Of note in this study was that patients were given an additional small volume of milk containing 1.5 mCi [^{99m}Tc]sulfur colloid at night (a bolus), in addition to the usual labeled feeding. We feel that the administration of a high concentration bolus, similar to what we are using in our technique, increases the sensitivity of the study. This is also borne out by the study of Muz et al., using a concentration of 2.5 mCi [^{99m}Tc]sulfur colloid in 20 ml water (5), who also reported a high detection rate, the study being

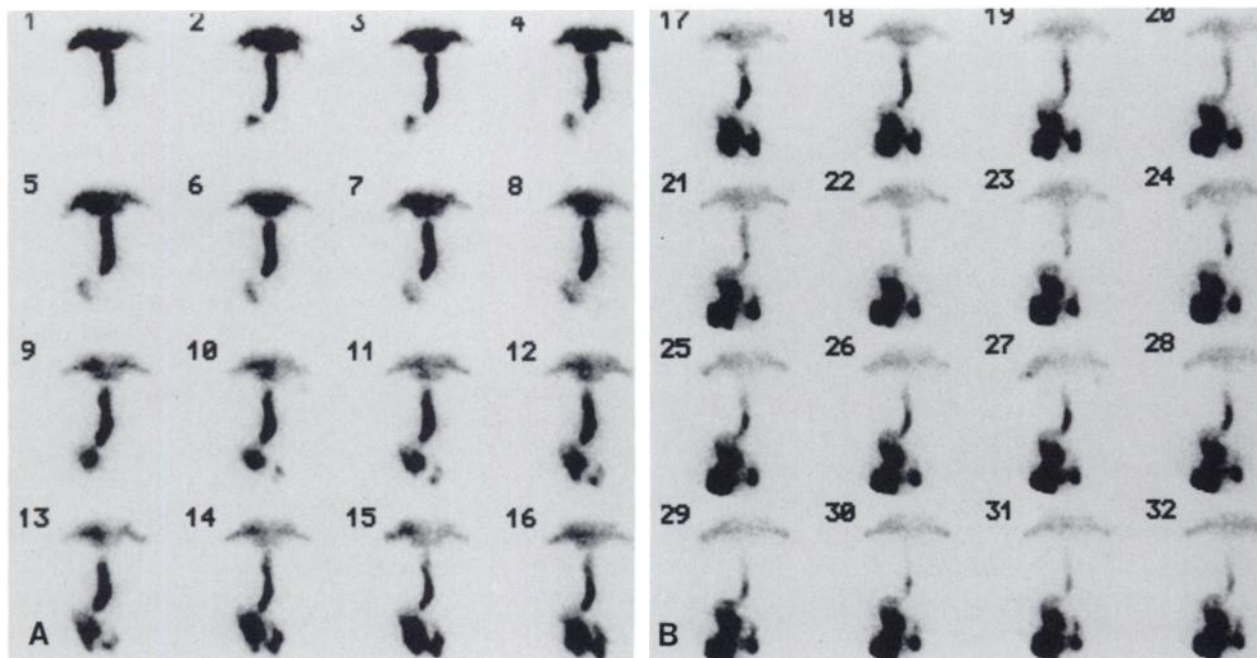


FIGURE 1

Patient 1, a 13-yr-old boy with cerebral palsy had difficulty with swallowing, choking episodes, and recurrent pneumonia. The salivagram, shown here, was negative for aspiration. Sequential digital images taken posteriorly over the first 32 min show normal transit from the mouth, down the esophagus, and into the stomach. A:1-16 min; B: 17-32 min.

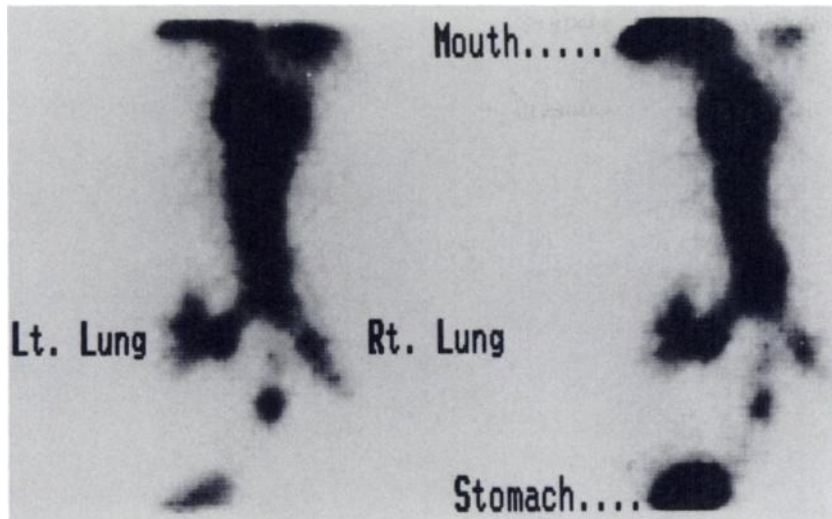


FIGURE 2
Patient 2, a 15-yr-old boy with cerebral palsy with recurrent pneumonia had this positive salivagram, showing aspiration into both lungs, more marked on the left side.

positive in 24 of 33 patients (videofluoroscopy being positive in 20). The concentration of the administered fluid is 125 $\mu\text{Ci}/\text{ml}$, far higher than the usual 3–5 $\mu\text{Ci}/\text{ml}$ in the “milk scan” for gastroesophageal reflux or gastric emptying. It is of interest that only one of four patients with tracheostomies had a positive study. The numbers are small, but are in contrast to the high prevalence noted by Muz et al., who reported 11 positive studies in 24 patients with tracheostomies (5).

From the foregoing it appears that the delivered dose, while not being greater than normally given in a milk feeding, should be in a higher concentration when the detection of aspiration is the object of the study. The salivagram as described will only document aspiration during swallowing, and records the aspiration of the patient’s oral secretions. This is of obvious interest in those patients who have difficulty in swallowing. It is possible, however, that positive patients are also at risk for aspiration if they have gastroesophageal reflux. We suggest that the salivagram be extended beyond the initial 1-hr period, till oral radioactivity is no longer evident. Once the oropharynx and esophagus are cleared of radioactivity, delayed images of the lung fields are obtained at 4 and 24 hr. Should aspiration be detected at this time, it is presumably the result of

gastroesophageal reflux. The sensitivity of this technique needs to be compared with the usual radionuclide reflux study and the barium swallow.

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