Imaging for Diagnosis of Foreign Body Aspiration in Children

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Foreign body aspiration into the airways is a significant cause of morbidity and mortality in pediatric patients, especially in children below 3 years of age. In the absence of clear history, the correct diagnosis is often missed. The clinical features may mimic asthma or pneumonia, resulting in delayed diagnosis. Cough or wheezing of sudden onset, reduced air entry on auscultation, and chronic or recurrent pulmonary infection are the subtle pointers which prompt an observant clinician to suspect foreign body aspiration. A foreign body lodged in the tracheo-bronchial tree warrants prompt removal to prevent serious respiratory complications as pneumonia, atelectasis, bronchiectasis and lung abscess [1].

Frontal radiograph of the chest is the initial investigation for children referred for persistent or severe thoracic symptoms. In up to 30% of cases of foreign body aspiration, no obvious abnormality is visible [1]. Positive *X*-ray findings consist of increased radiolucency of the lung or lobe, atelectasis, a combination of emphysema and atelectasis in the same lung, and pulmonary infiltrates [2]. Increased radiolucency (obstructive emphysema), which develops secondary to a check-valve mechanism created by the foreign body obstructing the airway, is the most common finding on chest skiagram [3]. Demonstration of radio-opaque foreign body on chest *X*-ray is seen in less than one-third of cases [3]. Presence of unilateral radiolucency is however a common finding in young patients due to imperfect positioning of an irritated child in unfamiliar surroundings. Also, subtle difference may be difficult to appreciate in a busy emergency department. A combination of inspiratory and expiratory film is most often required to demonstrate obstruction caused by the foreign body. Fluoroscopy and bilateral decubitus views of the chest have also been traditionally used for the diagnosis [1].

Computed tomography (CT) is an excellent modality for the diagnosis and may reveal the impacted foreign body directly as a hyperdensity in the lumen of airway [1]. It is also possible to differentiate low density foreign bodies from the mucous plug by determining the Hounsfield value [4]. Ancillary findings such as post-obstructive emphysema, collapse, consolidation and bronchiectasis are also well demonstrated. Advent of Multi-detector Computed Tomography (MDCT) has made it possible to obtain isotropic high resolution images in any desired plane. Thus it is possible to see and evaluate even a subtle abnormality. Multiplanar reconstructions, minimal intensity projection of the airway and virtual bronchoscopy provide an excellent roadmap to the surgeon for planning the endoscopic removal. With MDCT, Bai, *et al*. [5] were able to detect, localize and assess the crucial parameters of the foreign bodies in all of their cases who underwent endoscopic removal. Use of MDCT also obviated occurrence of severe complications in their cases.

Whereas the efficacy of MDCT in the evaluation of suspected foreign body is extensively backed up by the available evidence, large radiation exposure to the young patient with its potential long-term adverse consequences has spawned the need for exploring alternative low exposure methods which may be equally effective in the above clinical scenario. The radiation dose to a child of 1-5 years of age with a standard PA or AP view of the chest is about 0.01 mSv (milliSievert), while that with a CT scan of the chest with routine pediatric settings is of the order of 4-6 mSv. Low dose CT of the chest, done at low tube current, exhibit a significant reduction in radiation dose to the child, and is about 0.2 mSv with scans done at 30 mAs [6].

The retrospective study by Eun, *et al*. [7], published in this issue of *Indian Pediatrics*, is an effort in the direction of efficacious diagnosis of foreign body aspiration, with low radiation doses. The authors have objectively measured and compared the radiodensity of lungs in cases of foreign body aspiration in pediatric patients. The *X*-rays were taken using Computed Radiography (CR) system and the images were processed using the 'Histogram tool' of 'Adobe Photoshop Image Editing Software' to determine the relative radiodensity of the two lungs before and after foreign body removal. They found reduced radiodensity in the affected lung which increased after the removal of foreign body. The results were found to be statistically significant, and the authors conclude that measurement of radiodensity on chest *X*-ray can be helpful in the diagnosis of aspirated foreign body in the tracheo-bronchial tree, or alternatively, may be applied to rule out the possibility of

impacted foreign body in cases where the difference between radiodensity of the two lungs is not significant. The study essentially adds an objective component to analysis of the chest skiagram in cases of suspected foreign body inhalation. However, it is based on the premise that the patient had normal lungs and airways prior to inhalation of the foreign body. Thus results may be fallacious in patients having prior co-existing disorders. It would also require the integration of the CR system and Picture Archiving and Communication System (PACS) with the software for image evaluation, apart from delimiting the lung on the images. The entire procedure is a bit cumbersome and at best provides an indirect evidence of presence of foreign body in most cases. Further, more prospective studies would be desirable for validation of the above application.

The concern about minimizing the radiation exposure in CT scan has also necessitated introduction of innovations in the design of the CT equipments and child sizing of imaging protocols. These include automatic control of the tube current depending upon the body part being examined and introduction of new image reconstruction algorithms. It is also possible to exercise manual control by limiting the field of view, increasing the pitch, and decreasing the tube current and tube voltage. Conscious use of the above can markedly decrease the radiation dose in the target population while maintaining the diagnostic accuracy of the CT scan [8].

We maintain that MDCT is still the most reliable investigation for the diagnosis of aspirated foreign body, with the exception of bronchoscopy. Its utility is unlikely to be challenged in near future, provided all necessary means to reduce the radiation exposure are implemented scrupulously. Nevertheless, in the scenarios where the cost and availability of MDCT is a major deterrent to the acceptance of CT as the preferred modality, if digital radiographs of chest succeed in correctly suggesting or ruling out the diagnosis of foreign body lodgment, it would be of great benefit to a large number of affected patients.

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