Chapter 10

Upper airway in children: Medical application of CR

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Introduction

There are several methods to evaluate the upper airway in children. Direct observations can be made by laryngoscopy or endoscopy. Bronchography with the injection of contrast material is also a method for making a definitive diagnosis. However, these methods are rather invasive and some risks and complications cannot be avoided. The indication of these methods is, therefore, rather limited. The conventional radiographic examination taking the lateral nasopharyngeal view is noninvasive, but the diagnostic accuracy does not seem to be sufficient because of the poor resolution in observing the entire airway. Special techniques, including the high-voltage technique [1] and xeroradiography [2], have thus been introduced to provide better evaluation. However, especially in the case of small children with an abnormal upper airway, the choice of imaging method is limited and only radiographs utilizing a portable X-ray unit can be obtained in the ward or ICU because of the requirement of respiratory management. Therefore, it is rather difficult to obtain sufficiently good images to make the correct diagnosis.

Recently, computed radiography (CR) has been introduced with high resolution and wide latitude [3], moreover the images can be obtained using a portable X-ray unit. At our medical center, this method is considered suitable for the lateral nasopharyngeal view in children, whereby a very thin portion of the neck and a very thick portion of the thorax are included in one exposed field. We have used CR to make many evaluations of the upper airway in children [4].

Demonstrability of tracheal stenosis utilizing CR

When utilizing a regular film/screen system exposed by a portable X-ray unit, the range for adequate exposure is very narrow. Because a poorly exposed radiograph is inadequate for such an examination, radiologists often request technicians to use somewhat overexposed radiographic conditions. However, even utilizing a slightly overexposed technique, it is almost impossible to observe the entire upper airway including the mouth through to the lower trachea in one field. Generally speaking, an overexposed image is fairly easily corrected utilizing CR and the edge effect can be obtained using frequency enhancement. These two factors provide sharp uniform images of the entire upper airway (Fig. 10.1). We feel at our medical center that if we are able to obtain these images consistently at this quality, CR can replace tracheography, which has a potentially high risk (Fig. 10.2).

Anatomy of the upper airway

The narrowest portion of the upper airway is usually held to be at the level of the cricoid cartilage [5]. This has been documented with CR when the neck is positioned by pulling down the chin to reduce the lordotic curvature of the cervical spine (Fig. 10.3). However, when the chin is pulled up in the supine position, as endotracheal intubation is applied, the narrowest portion becomes at the level of the thyroidal isthmus. This is because of anterior bowing of the upper trachea with increased lordosis of the cervical spine associated with external indentation by the fixed thyroidal isthmus (Fig. 10.4). This is obviously the effect of physiological narrowing and the narrowest portion remains anatomically at the level of the cricoid cartilage.

Relationship between the endotracheal tube and upper airway

Endotracheal intubation is a standard procedure for general anesthesia and respiratory management of critically ill children and is widely applied. However, it is not known with certainty how the tube is situated in the airway, its attitude upon introduction,
The upper airway is bent at 90° from the oral cavity through the oropharynx to the larynx. Therefore, the endotracheal tube is also bent at this level at 90°. This produces a recoiling force toward the posterior wall of the upper trachea. This pressure was shown to be as high as 300–400 g with a PVC tube and 1000 g with a rubber tube [6]. The relationship between the endotracheal tube and the upper airway is elegantly demonstrated with CR (Fig. 10.5). The same endotracheal tube was introduced to the same patient through alternately the nasal and oral cavities, and the relationship between the upper airway and the endotracheal tube was evaluated with CR. With the tube introduced through the oral cavity, the anteroposterior (AP) diameter of the trachea increases compared with that with nasal intubation (Fig. 10.6). The more the endotracheal tube bends, the greater is the recoiling force toward the posterior wall of the anteriorly convex cervical trachea. The recoiling force is conducted to the tip of the tube against the anterior wall of the trachea, widening the AP diameter at this level.

When the endotracheal tube is introduced, the tube descends vertically to the glottic portion and the