Mechanism of Endotracheal Tube Movement with Change of Head Position in the Neonate

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Abstract. The mechanism of alteration of endotracheal tube position with movement of the head and neck in the neonate was studied in a term newborn cadaver. The infant was intubated and serial radiographs were obtained with the head and neck in different positions. We propose that the skull acts as a lever arm from the anterior end of the maxilla to the first cervical vertebra. The fulcrum for movement of this lever arm is the upper cervical spine. Movement of the endotracheal tube in the trachea is directed by the maxillocervical lever arm when the skull and upper cervical spine are flexed, extended, or rotated.

Key words: Endotracheal tube – Neonate – Radiography

Several investigators have reported alteration of endotracheal tube position with head movement and its potential deleterious clinical effects in both adults and children [1–6]. A theoretical explanation for the mechanism of tube movement has been proposed for adults [2], although this hypothesis was not based on experimental data. To our knowledge, the mechanism of tube movement has not been studied in the neonate. We report herein the results of an investigation into the mechanism of endotracheal tube movement in the neonate.

Methods and Materials

The study was performed post-mortem on a term newborn, 24 hours after he expired on the second day of life. The infant had a meningomyelocoele and Arnold-Chiari malformation, but subsequent autopsy revealed no additional anomalies of the head and neck or airway. There was no rigor mortis. Informed consent had been obtained from the parents, who had released the body for anatomical studies.

The infant was intubated orally with a 3.5 mm constant diameter polyvinyl chloride endotracheal tube with a radiopaque marker at its tip. The tube was inserted to its 9 cm marker, and with the head in the neutral position the tip was located radiographically at the level of the thoracic inlet. The tube was (as in clinical use) secured with tape, and a stainless steel safety pin was placed through the tube at the level of the upper lip to serve as a reference marker and to prevent inadvertent movement of the tube in relation to the maxilla during changes of head position.

Lateral radiographs of the head and neck were obtained with the infant's head in the flexed, neutral, and extended positions, and with the head rotated laterally. Antero-posterior radiographs were obtained with the head in neutral and rotated positions.

Results

Figures 1 and 2 show the change of the endotracheal tube position with movement of the head and neck. These results are in agreement with previous studies [2–6]; the tube tip moves caudad (towards the carina) with flexion, and cephalad (towards the glottic opening) with extension. Lateral rotation causes the tube tip to move cephalad as well. There was no movement of the reference marker in relation to the maxilla, indicating that the tube remained stationary at its site of fixation to the mouth.

Discussion

Figure 3 represents a schematic diagram of our proposed mechanism for the movement of the endotracheal tube tip with change in head and neck position. In our neonate flexion and extension of the cervical spine occurred primarily through the first four cervical vertebrae (C₁–C₄ in the diagram) with the
Fig. 1a–d. Lateral radiographs of intubated neonate cadaver. Body of seventh cervical vertebra is marked 7. a Head and neck in neutral position: Endotracheal tube tip is at level of C6–C7 interspace. b Head and neck in flexed position: Endotracheal tube tip is at C7. c Head and neck in extended position: Endotracheal tube tip is at C6. d Chin in neutral position, head rotated laterally: Endotracheal tube tip is at C6.