SWISS SOCIETY OF NEONATOLOGY

Winner of the Case of the Year Award 2010

Fatal tracheal rupture in an extremely preterm infant

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This first pregnancy of a 21-year-old G2/P2 was complicated by severe, early-onset intrauterine growth restriction (IUGR) with an estimated fetal weight of less than 300 g at 24 weeks of pregnancy. Elective delivery was not considered to be a reasonable option at that time and the parents were informed about the risk of intrauterine fetal demise (IUFD). However, at 25 4/7 weeks of gestation, the infant was delivered by primary Caesarean section due to maternal preeclampsia.

The male preterm infant with a birth weight of 560 g adapted well with an Apgar score of 7, 8 and 8 at 1, 5 and 10 minutes, respectively. He rapidly developed signs of respiratory distress while on continuous positive airway pressure with an FiO2 of 0.4. An umbilical venous catheter was placed to prepare for semi-elective intubation and surfactant administration.

Following premedication with morphine and atracurium, bag-mask ventilation was easily achieved. At 12 minutes of age, a size 2.5 endotracheal tube (ETT) was inserted through the right nostril. Although the vocal cords could readily be identified, the ETT could not be advanced into the trachea. When the $tcSaO_2$ decreased to less than 80%, the intubation attempt was interrupted, the ETT was retracted to 4 cm and the infant recovered while being ventilated through this nasopharyngeal tube. The first operator was replaced by a more senior staff member. On the second attempt, the 2.5 ETT was advanced through the vocal

cords with the use of a Magill forceps. With the first compression of the Ambu® bag, there was obvious bulging of the subcutaneous tissue overlying the larynx anteriorly and ETT malposition was immediately recognized. The ETT was removed and bag-mask ventilation was attempted but unsuccessful. Nasotracheal reintubation with a 2.0 ETT was performed but again there were no chest excursions but again bulging of the subcutaneous tissue. The infant became progressively cyanotic with the exception of a bright red discoloration in the neck region (Fig. 1, 2). When the heart rate fell below 60 bpm, chest compressions were started. Two additional orotracheal intubation attempts with a 2.0 ETT with a stylet were unsuccessful. Resuscitation attempts were finally discontinued at the age of 35 minutes.

A postmorten CXR revealed bilateral tension pneumothoraces and subcutaneous emphysema of the neck (Fig. 3). A forensic autopsy was performed three days after the infant's death and confirmed these findings. There was no tracheal malformation. Because of advanced autolytic changes the precise location of the perforation could no longer be determined.

Fig. 1

Postmortem photograph (lateral view) showing bright red discoloration in the area of the palpable subcutaneous emphysema.

Fig. 2

Postmortem photograph (anterior view) showing bright red discoloration in the area of the palpable subcutaneous emphysema.

Fig. 3

Postmortem chest X-ray showing bilateral tension pneumothoraces and subcutaneous emphysema of the neck.

DISCUSSION

Tracheal rupture has been reported as a rare complication of endotracheal intubation in both adults (1-6) and children (7-16). Direct trauma during intubation may result from the endotracheal tube, the stylet or the laryngoscope. Most cases manifest with subcutaneous emphysema, respiratory distress and pneumothorax. But, as in our case, tracheal rupture with the creation of a false passage may result in the inability to ventilate, rapid respiratory failure and death. In their review of the literature, Doherty and colleagues reported a very high case fatality rate of 75% in 8 neonatal cases compared with only 9% in 35 adult cases (8).

Typically, in adults the lacerations occur in the posterior membranous part of the trachea (3, 4, 17). In contrast, the area of tracheal injury in neonates more commonly involves the anterior wall in the subglottic or tracheal region (8, 10, 14, 15). Doherty and colleagues have speculated that the neonatal trachea maybe more vulnerable due to the higher elasticity of the immature cartilage and weakness of the inter-cartilaginous membrane (8). Additional risk factors (2, 5, 6, 11) that have been associated with tracheal injury during intubation are listed in the Table.

This tragic case has prompted us to review our intubation procedure in preterm neonates. In our institution, delivery of extremely preterm infants are always attended by two experienced neonatologists. A naso-

Procedure-related factors
Blind intubation/poor visualization
Hurried intubations
Multiple attempts
Poor positioning, excessive hyperextension
Inadequate muscle relaxation
Clinical inexperience
Excessive external laryngeal pressure
Use of metal guide wire or Magill forceps
Mechanical factors
Protruding stylet
Tube repositioning without cuff deflation
Excessive movement of the patient, vigorous coughing
Overinflation of the cuff
Eccentrically inflated endotracheal cuffs
Patient-related factors
Systemic hypotension
Difficult anatomy
Decreased cervical mobility
Congenital/acquired laryngotracheal lesions
Post-surgical (laryngo-tracheal reconstruction, tracheal resection)
Cervical trauma, previous intubation or tracheotomy
States affecting chronic wound healing

Table

Risk factors associated with iatrogenic tracheal injury (factors that may be particularly relevant to the neonate are printed in bold) (adapted from Doherty et al.).

gastric tube is used to guide the lubricated ETT through the nose into the hypopharynx (Fig. 4). The nasogastric tube is then retracted 1 cm proximal to the tip of the ETT. Following visualization of the vocal cords, the tip of the ETT is placed on top of the posterior commisure between the arytenoids with the help of a Magill forceps (Fig. 5, 6). The ETT is then advanced through the vocal cords using gentle pressure and slight rotational movement of the ETT (Fig. 7). Slight flexion of the neck may bring the ETT more in line with the trachea; this helps to avoid pushing the tip of the ETT against the anterior wall of the trachea. Occasionally, readvancing the nasogastric tube beyond the tip of the ETT at this stage may help to guide the ETT into the trachea. The Magill forceps should never be used to force the tip of the ETT below the local cords.

Intubation of extremely preterm infants can be challenging. It should be considered a high risk procedure even when it is performed by skilled operators after careful preparation.

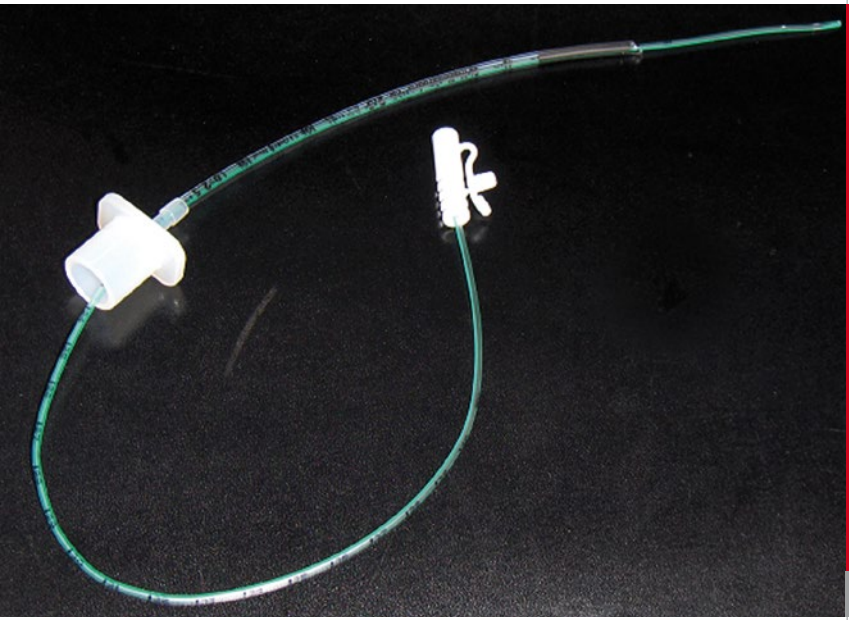

Fig. 4

A nasogastric tube inserted through the ETT is used to guide the passage through the nose; it can also be used to facilitate insertion into the trachea.

Fig. 5

The Magill forceps is used - if necessary - to place the tip of the ETT on top of the posterior commisure between the arytenoids (see Fig. 6).

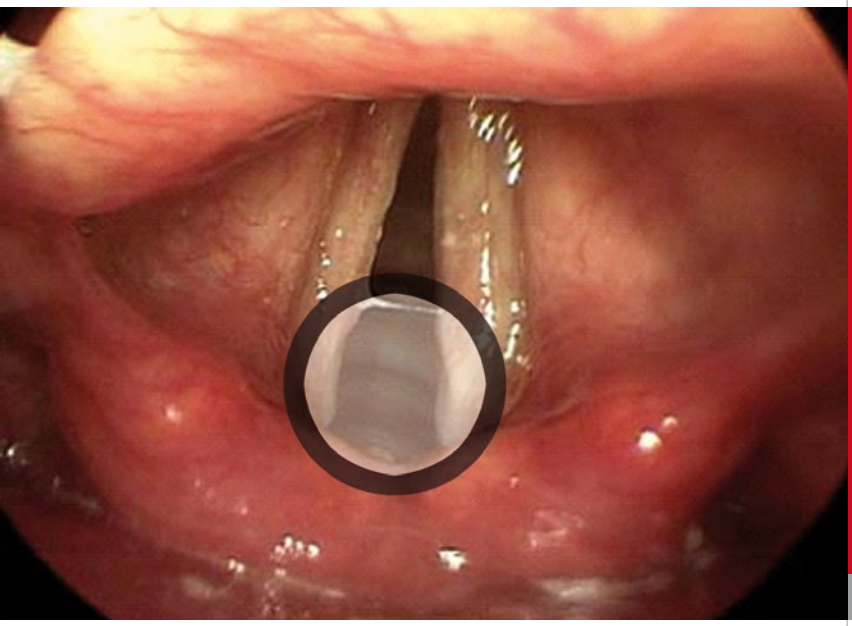

Fig. 6

The tip of the ETT is placed on top of the posterior commisure between the arytenoids (marked by gray circle).

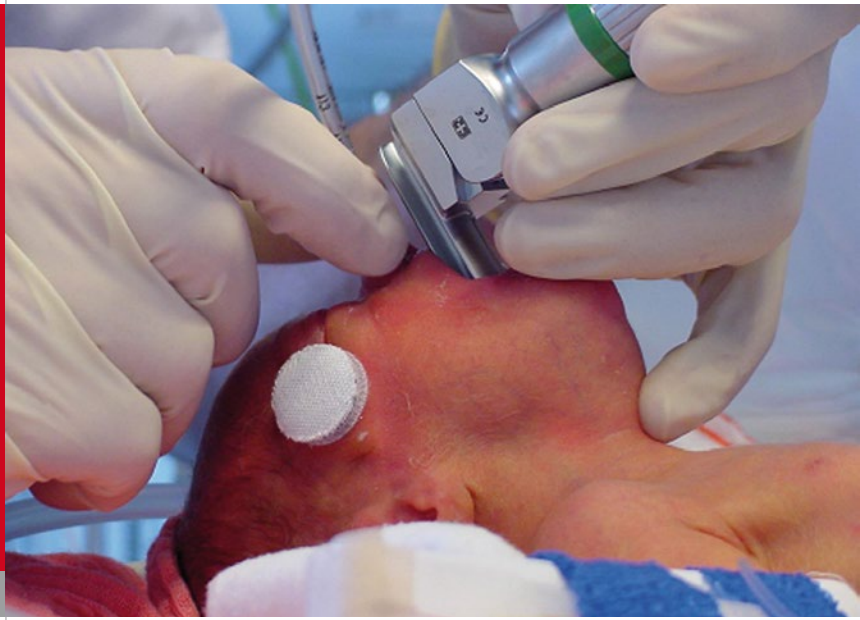

Fig. 7

The ETT is advanced through the vocal cords with gentle pressure and slight rotational movement of the ETT; slight flexion of the neck may bring the ETT more in line with the trachea and helps to avoid pushing the tip of the ETT against the anterior wall of the trachea.

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