Endoscopic Assessment of the Airways & Failed Extubation

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Difficult management problems can arise, when we are referred babies by the pediatric intensive care unit, who for one reason or another, when the intensivist tried to remove the endotracheal tube to extubate the child they were unsuccessful. Then the pediatric otolaryngologist is asked to assess the problem and correct it. This requires that we take a history and examine the baby, and then we plan a Microlaryngoscopy and Bronchoscopy (MLB) under a light general anesthetic in the operating room. The procedure is both diagnostic and sometimes therapeutic. If we discover an airway problem which we can correct with cold micro-instruments or the laser or a balloon, we try to do this, to allow successful extubation of the baby. We mostly use the Storz rigid endoscopes & bronchoscopes, we also sometimes use the flexible endoscope on the ward, but with an intubated baby we are going to the operating room (OR) and the rigid instruments with laryngeal suspension allows us two hands and control for endoscopic procedures. We operate from the monitor screen mostly holding a 4mm wide zero degree endoscope. In most cases the baby is in suspension laryngoscopy and we have a hand free to manipulate and perform surgery. When necessary we go down into the bronchus with the ventilating bronchoscope. If we need two hands for endoscopic surgery or want to use the CO_2 laser with the micromanipulator, we use the operating microscope instead of the endoscopes.

The aim of the endoscopy is to confirm if the reason for the failed extubation is due to an airway obstruction and to determine at which level anatomically it exists, what is the cause and nature of it and whether we can correct the problem. So we exclude the other non-airway causes mentioned below from the history, then we examine the upper airway down to the larynx, the supraglottic larynx, the vocal chords (including their movement) and the subglottis and tracheo-bronchial tree.

We could have an extubation problem with for instance, a subglottic cyst. This could be caused by intubation and this is actually an extravasation or mucus retention cyst. The cyst on the subglottis can cause airway obstruction and stridor. When we remove it, either with cold instruments or with the laser we establish a normal-sized airway. So, it is a very quick therapeutic, endoscopic procedure.

It is not so easy when we find very severe subglottic stenosis. We could also find other laryngeal pathologies such as vascular causes; unilateral or bilateral subglottic hemangiomas, a posterior laryngeal cleft, vocal chord paralysis, or papillomatosis for example. Often the problem, with the intubated baby is damage from the intubation itself, with mucosal ulceration, oedema and intubation granulomas. We also can find the reason of the failed extubation is an upper airway obstruction at a level higher than the vocal cords, typically a baby with

micrognathia, a prolapsing epiglottis and glossoptosis, when the tongue base and epiglottis fall back and downwards over the glottis introitus, obstructing the airway. Sometimes, the airway obstruction is lower in the airway such as tube tip granulomas or tumours, a vascular obstruction compressing the trachea or main bronchi (eg a double aortic arch or an aberrant left pulmonary artery), generalized trachea-bronchomalacia or a congenital long segment micro-trachea, in which the tracheal rings are complete circles and do not enlarge with growth.

Checking joint mobility

When performing the diagnostic Microlaryngoscopy and Bronchoscopy (MLB) and assessing a baby's vocal chords, we like to differentiate between cords not moving because of neuro-muscular paralysis (vocal chord palsy) and the problem we see in prolonged intubation babies, of the vocal chords being fixed because the cricoid-arytenoid joint is fixed. So, we use a probe to check if the vocal folds can be moved. And then we want to look at the airway under a lighter anaesthetic, dynamically, to see the vocal chords abducting, moving apart, when the baby breathes in, in order to see if there is normal neuromuscular active movement.

Vocal chord palsy

When there is a bilateral vocal chord paralysis, the vocal chords move in what we call paradoxical movement. They are suck together by the inspiratory air flow. So on inspiration the vocal chords move together, rather than apart. When there is normal vocal chord movement and no paralysis we should see both chords abducting as the baby inspires.

The conditions for general anaesthetic is very important in paediatric and neonatal endoscopy. We need to have the baby breathing spontaneously without any endotracheal tube in place, yet not so 'light' that he/she moves or goes into laryngospasm, and not so 'deep'that he/she stops breathing. We achieve this by using lidocaine local anaesthetic sprayed on the larynx and the anaesthetists use inhaled oxygen, isofluorane or cevofluorane and small boluses of propanolol given intravenously.

Extubation Failure

In a study by Seymour et al. they looked into their experience with babies that failed extubation. Co-morbid conditions and underlying anatomical abnormalities pre-disposed to extubation failure [1].

Extubation failure means that the baby is unable to maintain oxygen levels (pO_2) and Carbon dioxide (CO_2) goes up. For a successful extubation the baby has to breathe well, has to have a good respiratory drive, adequate neuro-muscular activity, good heart, good lungs, clear airways, and not be septic. These are the physiological requirements.

We conducted a retrospective study on failed extubation with the objective of assessing the need for surgical interventions and to assess outcomes [2]. This study was also undertaken to see if we could devise a protocol to manage these babies. Our retrospective study consisted of 44 patients who were referred to me from PICU, with failed extubation. The failure of intubation was defined as the reinstitution of intubation & mechanical ventilation within 72 hours, which meant

that the tube had to be put in again, early on, with 72 hours of its first removal.

In assessing outcomes, "Conservative" management was considered to have been successful if the patient was subsequently extubated without further surgical intervention. The problem we have when we look at these babies at endoscopy is to decide what to do. We are able to simply put the tube back, and say: the child needs more time, more rest. What we call therapeutic reintubation (little pathology – therapeutic reintubation) [3].The concept of laryngeal rest however demands that an age appropriate sized tube is inserted but it is secured without undue tube movement, so the baby has to be deeply sedated or even paralysed for a few days, to allow the larynx to heal. Systemic steroids are also given to reduce inflammatory granulations and oedema.

Alternatively, we can use the endoscope, lasers, and microsurgical instruments to remove an obstruction; to drain a cyst or to remove granulomas. And then try again to extubate, either immediately or after a short period of therapeutic reintubation (6 - 48 hours).

Sometimes there is isolated subglottic pathology with no swelling or trauma at the vocal chords or above. In these cases we can do a cricoid split or a single stage laryngotracheal cartilage reconstruction.

On other occasions there is no quick fix. For those with more severe transglottic disease – severe inflammation and granulations from above the cords extending into the subglottis - and we have to do a temporary tracheostomy. We then truly achieve laryngeal rest with no new trauma from an ET-tube. We then plan to look again at the airway endoscopically after about three weeks, hoping the larynx has settled enough to remove the tracheostomy. Sometimes, however, it has formed a more mature sug-glottic stenosis and will need later reconstruction.

We reviewed the 44 patients, the median age was four months of age, the mean age was just almost a year (28 males and 16 females). And we found that 45% of them were managed conservatively. By which I mean that we only had a look and we thought that the damage to the larynx was not severe and we were able to put the tube back and give the intensive care doctor some advice about the protocol of how to manage it. And the other 55% needed some sort of intervention, or surgery. Failure extubation results are shown in **Figure 1.**

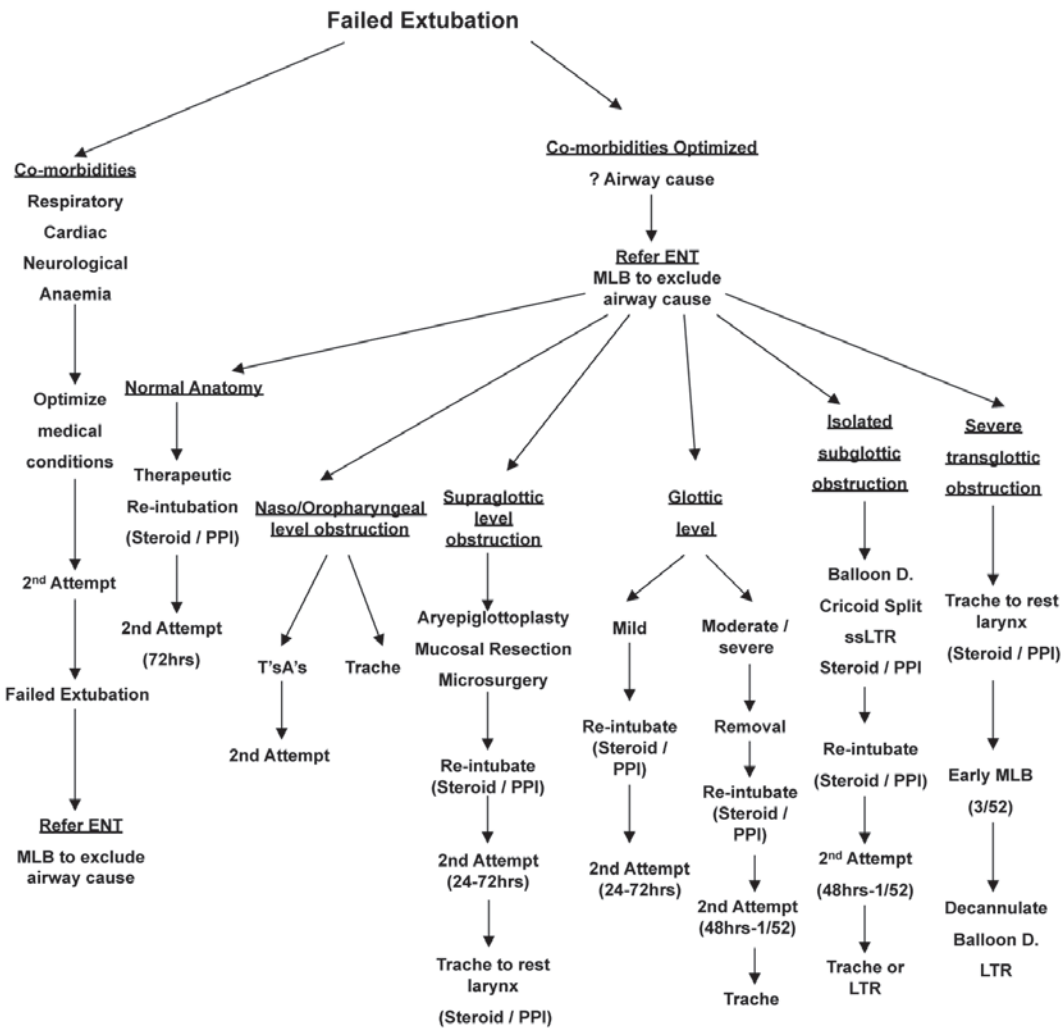
Figure 1. Failure extubation results

- 24 had minor Endoscopic findings & no endoscopic procedure reintubation
- 14 patients underwent initial microsurgery (laser or 'cold steel')
    - Of whom one patient had an endoscopic cricoid split
    - Of whom 5/14 patients subsequently required tracheostomy
- 6 patients underwent tracheostomy as primary procedure
- 4 patients of above groups underwent LTR/Cricoid split

Twenty four only had minor abnormalities under laryngoscopy. Fourteen, however, underwent some surgery, to therapeutic endoscopic surgery. One was an endoscopic cricoid split, five of the 14, however, later failed a second attempt and had to have a tracheostomy. In six of the patients we decided to do a tracheostomy straight away, because of the nature of the pathology. Four of the patients had a cartilage graft - LTR (laryngo-tracheal reconstruction) or a cricoid split as well. Overall, about half the patients (50%) required some form of surgical intervention. The form of surgical intervention is dictated by the level of the airway obstruction and the nature of any airway pathology.

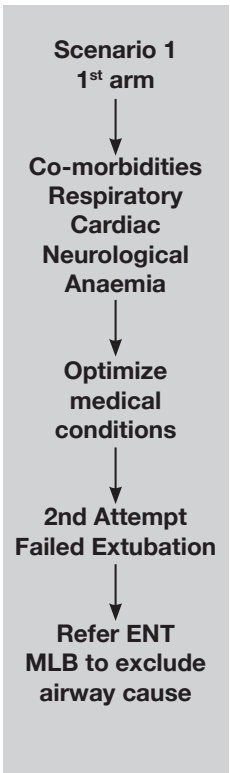
From the study, we decided to look at the outcomes and see if we could draw up a protocol. We proposed a management protocol flowchart for these difficult cases. (**Figure 2).** Now let's see each column.

Figure 2. Protocol flowchart for difficult cases.



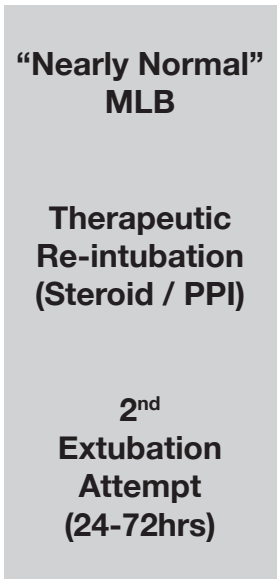
First the column at the left. The first one arm of the first scenario - (**Figure 3**) is the child who has nothing wrong with the airway but failed extubation for other reasons. The problem might be respiratory or cardiac, or else a neurologic problem where there is no respiratory drive. So, you have to go back and optimize the medical conditions. Otherwise, we will not succeed.

Figure 3. The child has nothing wrong with the airway



The second arm (**Figure 4**) is a baby who has a nearly normal microlaryngoscopy, and bronchoscopy. In this situation we say there are multiple factors. Perhaps there has been some sepsis, we will try again and we will put the tube back in but keep tube movement to an absolute minimum and give steroids as well.

Figure 4. When the baby who has a nearly normal microlaryngoscopy, and bronchoscopy



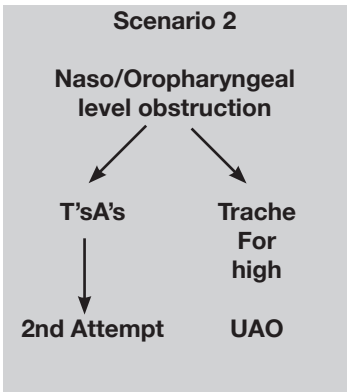
Our therapeutic Re-intubation protocol is:

- we put an age-appropriate tracheal tube, fixed nasally;
- we ask the intensive care doctors to paralyze and ventilate the child on PICU for two days;
- we also use steroids - prednisolone or dexamethasone;
- give anti reflux medications (ranitidine or omeprazole);
- after 48 hours stop paralysis/heavy sedation and wean to trial extubation;
- air-leak may not be expected;
- if difficulty anticipated wean to nasal prong CPAP (continuous positive airway pressure);
- only discontinue steroids a few days after extubation.

This protocol allows the larynx to settle and the swelling to reduce.

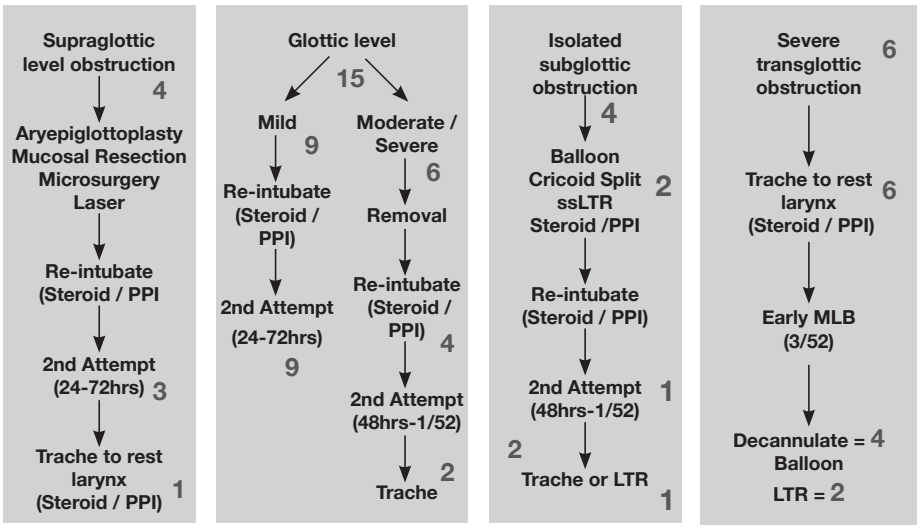
The third arm, scenario 2, (**Figure 5**) is a patient with an upper airway problem above the larynx (very large adenoids or tonsils for instance) if we see this problem we try to correct them. A congenital airway narrowing such as is seen in Treacher-Collins Syndrome or Pierre-Robin Sequence however might require a tracheostomy.

Figure 5. A patient with an airway problem (very large adenoids or tonsils for instance)



Scenario 3 we have four arms (**Figure 6**). Laryngeal pathologies comprise the most common group. We occasionally find supraglottic & vocal chord oedema and sometimes you can release or vapourise this oedema fluid with a laser. In some other cases we see exposed cartilages and intubation granulomata. When you take the tube out and you wait 10 minutes for the child to breathe you will see the swelling returning and you will understand why the child fails intubation later. You also could have some cysts that could be laser/drained. Sometimes the narrowing is too great and we may consider opening the airway with the cricoid split or a single stage of laryngo-tracheal reconstruction (LTR). This is only a good choice if the pathology is isolated in the subglottis, otherwise you would correct that region with an LTR operation, but still fail extubation because of the glottis and supraglottic damage.

Figure 6. Laryngeal pathology (the nunbers refer the amount of cases)



When we find that the problem is a severe trans-glottic from the supra-glottis to the sub-glottis with a small tube and ulcerations and granulations, there is no way that I can correct it. So I will "rest" the larynx by performing a tracheostomy and then we try to remove the tracheostomy and re-endoscope very early in the hope we could avoid major reconstruction.

What is the place for "emergency" of single stage for cartilage graft reconstruction (LTR) surgery? We advise the following:

- baby ideally over 2.4 kg weight;
- limited or NO O_2 requirement;
- isolated or nearly isolated SUBGLOTTIC narrowing;
- Cotton Grade 1 – 2 stenosis;
- subglottic narrowing composed of soft mature scar tissue, not simple oedema.

Conclusions

- approximately 50% of failed extubation referrals required therapeutic endoscopic or open surgery;
- 72% (32/44) patients were successfully treated with therapeutic reintubation alone or in conjunction with micro-endoscopic surgery;
- 25% (11/44) initially or eventually required a tracheostomy;
- 11% - 3 underwent LTR & 2 cricoid split surgery;
- a protocol for surgical management has been derived.

References

1. Seymour C. Failed extubation in the paediatric setting is associated with a marked increase in both morbidity and mortality. Crit Care 2004.
2. Agrawal N, Black M, Morrison G.Ten-year review of laryngotracheal reconstruction for paediatric airway stenosis. Int J Ped ORL. May 2007 Vol. 71; Issue 5: 699-703.
3. Hoeve LJ, Eskici O, Verwoerd CDA. Therapeutic reintubation for post-intubation laryngotracheal injury in preterm infants. Int J Ped ORL. Jan 1995 Volume 31; Issue 1: 7-13.