Role of tracheostomy in the management of foreign body airway obstruction in children

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ABSTRACT

Introduction: Foreign body aspiration in the airway of children is a life-threatening clinical situation. Endoscopic retrieval alone is successful in the majority of patients. Occasionally, open surgical intervention in the form of tracheostomy, thoracotomy and bronchotomy and/or pulmonary resection is needed. We analysed the specific indications for tracheostomy during the removal of airway foreign bodies in our study.

Methods: The records of four patients who needed tracheostomy, out of 342 cases of foreign body airway obstruction managed by the senior author, were analysed. These patients underwent an additional tracheostomy for open removal of the foreign body and/or to secure the airway to facilitate the foreign body removal.

Results: Rigid bronchoscopy was successful in retrieving the foreign bodies in 338 (98.8 percent) cases, while four (1.2 percent) cases required additional tracheostomy, either to protect the airway during the procedure or to assist in removing the foreign body. The indications for tracheostomy were subglottic foreign bodies of long duration, sharp subglottic foreign bodies and foreign bodies that were larger than the glottic chink. There was no mortality or long-term complication because of the tracheostomies.

Conclusion: Tracheostomy is occasionally indicated in foreign body extraction, when they are subglottic in location and impacted, or are large foreign bodies that get obstructed at the glottic chink during removal.

Keywords: airway obstruction, bronchoscopy, foreign body, tracheostomy

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INTRODUCTION

Foreign body (FB) airway obstruction is a life-threatening clinical situation. This worldwide problem is responsible for many deaths each year, with children less than two years of age being the most commonly affected. The FB is removed by bronchoscopy in the majority of patients, but in highly-selected cases, after the preliminary bronchoscopy/attempted FB extraction, the surgeon may use additional tracheostomy which entails a lower risk as it protects the underlying airway or facilitates removal, and reduces the need for repeated attempts at bronchoscopic extraction. The purpose of this study was to report our experience with four (out of 342) cases of airway FB in children that required additional tracheostomy for successful extraction, and to discuss the indications for tracheostomy in airway FB cases.

METHODS

During the period 1998–2007, a total of 342 cases of FB airway obstruction were treated in our department by the principal author. The records of these patients were analysed, and formed the basis of this study. Rigid bronchoscopy, using Karl Storz ventilating bronchoscopes of the appropriate size (Karl Storz GmbH & Co KG, Tuttlingen, Germany), was performed in all the cases. All the patients underwent inhalational induction using increasing concentrations of halothane (0.5%–3%). With the exception of suspected subglottic FBs, the other patients with suspected FB airway obstruction where mask ventilation was deemed possible, were deeply anaesthetised with a depolarising muscle relaxant, succinylcholine (1 mg/kg) and bronchoscopy was perfomed. During bronchoscopy, the patients were manually ventilated by connecting the breathing circuit to the sidearm of the bronchoscope. However, if the time taken for bronchoscopic removal of the FB, as assessed by the surgeon, was to be prolonged, the patients were then administered a non-depolarising muscle relaxant (intravenous [IV] atracurium 0.5 mg/kg IV) and the airway was secured with an appropriately-sized PVC endotracheal tube (ET). The patients were also administered IV fentanyl (1 μg/kg) for analgesia.

The patients were kept on positive pressure ventilation

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Table I. Clinical details of the patients who underwent tracheostomy.

Case	Age (years)/ gender	Duration of symptoms	Foreign body	Respiratory distress	Procedure
1	0.5 / M	1 month	Metallic spring	Absent	Bronchoscopy & tracheostomy
2	3 / M	24 h	Fish bone	Present	Bronchoscopy & tracheostomy
3	7 / M	18 h	Pen cap	Present	Bronchoscopy & tracheostomy
4	6 / F	48 h	Tamarind seed	Present	Bronchoscopy & tracheostomy

using the Datex Ohmeda S/5 machine (GE Healthcare, Bangalore, India). Anaesthesia was maintained with oxygen, halothane (0.5%–1%) and intermittent doses of atracurium. At the end of the surgical procedure, the muscle relaxation was reversed with neostigmine (0.5 mg/kg) and atropine (0.25 mg/kg). Intraoperatively, the patients were monitored for oxygen saturation, end-tidal carbon dioxide, non-invasive blood pressure, and with electrocardiography and precordial stethoscope. They were then moved to the post-anaesthesia care unit after regaining consciousness and protective airway reflexes, for a four-hour observation. Four patients, who required additional tracheostomy, also needed different anaesthetic and surgical techniques, and these are described below. The clinical details of these four patients are listed in Table I.

RESULTS

Rigid bronchoscopy using an appropriately-sized Karl Storz ventilating bronchoscope alone was successful in retrieving the FB in 338 cases, while four cases required an additional surgical procedure in the form of tracheostomy. Case 1 was a six-month-old male infant. No clear history of foreign body aspiration could be elicited from the parents, and the duration for which the FB was lodged was also unknown. However, an inspiratory stridor which had persisted for a month, worsened when the infant developed upper respiratory tract infection. Radiography of the neck (soft tissue) showed that a coiled spring was located in the subglottic position (Fig. 1). It was probable that the infant's elder sibling had introduced the spring into his mouth when there was no parental supervision. Rigid bronchoscopy revealed the coiled spring located below the glottis, it was partially visible and covered with granulation tissue infiltrating the lumen of the spring, and bleeding occurred on contact with the bronchoscope tip and suction tube. As a subglottic FB was suspected, muscle relaxant was not administered. After the initial assessment under halothane anaesthesia with a mask, the airway was secured by open tracheostomy via a neck incision using a Portex 3.5-mm tracheostomy tube (Smiths Medical, St Paul, MN, USA). Airway ventilation was handed over to the anaesthetists. Subsequent bronchoscopic reassessment of the airway above the tracheostomy site was done under the same anaesthesia. The coiled spring was safely retrieved bronchoscopically using a pair of optical forceps (alligator) via a 3.5 Karl Storz bronchoscope, through the mouth after securing the distal airway by tracheostomy. The occasional bleeding was controlled using an instillation of one part in 10,000 solution of adrenaline and suction. Weaning from the tracheostomy was slow (one month) due to the presence of underlying subglottic stenosis.

Case 2 was a three-year-old girl who had choked after eating. There was an acute onset of difficulty in breathing following the consumption of some non-vegetarian food. The child had loss of voice as well as inability to swallow saliva. The radiograph of her neck showed a radiopaque foreign body in the subglottic region. Since this patient was our first patient, our anaesthetist administered a short-acting muscle relaxant, and we could not pass a bronchoscope through as there was something impacted in the subglottic area just below the vocal cords. We continued mask ventilation until a tracheostomy was done. The anaesthetist had airway control throughout the tracheostomy. During the same sitting, a fish bone was removed in a retrograde fashion through tracheostomy. The patient was weaned from tracheostomy within 72 hours.

Cases 3 and 4 had a clear history of FB aspiration, and the nature of the FB was known to the respective parents. In Case 3, a seven-year-old boy, the diameter of an identical pen cap (Fig. 2) similar to the one aspirated, was measured and found to be 1 mm smaller than the expected subglottic diameter for that age. Hence, it was anticipated that a tracheostomy may be necessary to retrieve the FB. During rigid bronchoscopy using a Karl Storz ventilating bronchoscope and a pair of optical forceps, the pen cap became impacted at the subglottic region while removal was repeatedly attempted. A tracheostomy to remove the pen cap was planned. The patient was ventilated with an ET from the mouth and underwent a tracheostomy through a neck incision. At this point, the orotracheal tube was withdrawn up to just below the glottis and another ET tube was passed from the tracheostomy, and the ventilation was

Fig. 1 Lateral neck radiograph shows a coiled spring in the subglottic position.

Fig. 2 Photograph shows the pen cap retrieved from the tracheostomy.

handed over to an anaesthetist. The tracheostomy edges were held with 3-0 vicryl to facilitate the introduction of the bronchoscope/ET tube. The ET was then removed and a 5-mm bronchoscope was passed into the trachea and connected to the anaesthetic circuit for anaesthetic airway control. We removed the pen cap, holding it with a pair of Karl Storz alligator forceps via the tracheostomy. The ET was removed and a Portex tracheostomy tube was introduced and fixed. The patient's airway breathing was assessed by gradually occluding the tracheostomy tube, and the patient was weaned off the tracheostomy at seven days postoperation.

In Case 4, a tamarind seed was impacted in the right main bronchus and had swelled up in the bronchus of a six-year-old girl. It was getting impacted at the glottic inlet while bronchoscopic retrieval was attempted. Hence, after three unsuccessful bronchoscopic attempts, a tracheostomy was done to remove the FB. The technique was the same as that described for Case 3. The patient was weaned from tracheostomy within 72 hours. The tracheostomy management consisted of suction, humidification and oxygen administration as per our protocol. The duration of follow-up ranged from 2–10 (mean 6.5) years. None of the children suffered any long-term morbidity.

DISCUSSION

FB aspiration is a life-threatening emergency requiring immediate intervention.[1] Even in the hands of experienced endoscopists, there may be occasions when an endoscopic approach to airway FBs should be abandoned in favour of an open surgical procedure.[2] Open surgical intervention for FB airway can be in the form of tracheostomy, thoracotomy and bronchotomy and/or pulmonary resection. The need for open surgical intervention ranges from 0.3% to 4% in various published series.[2,3] In a review of 6,693 cases of airway FB, 2.5% required thoracotomy and 2.0% required tracheostomy.[4] Airway FBs lodge most commonly in the bronchus (> 70%). However, the larynx is the first stop before the right main bronchus. Laryngeal FBs form only a small group of FB aspiration in children, but they are potentially more dangerous, with respect to both presentation and management.[5] Children may present with complete airway obstruction, causing acute respiratory stridor and distress, and even respiratory arrest. Laryngeal FBs may present with symptoms like a sudden onset of aphonia, hoarseness of voice, dysphagia and drooling of saliva with/without evidence of airway compromise. In the absence of respiratory complaints, these children can present late,[6] as did one child in our series. In Case 1, the initial bronchoscopy revealed an oedematous subglottic area with granulation tissue all around the coiled spring, and the airway was patent only due to the hollow nature of the spring. Endoscopic manipulation without tracheostomy was likely to be risky and associated with airway compromise. In Case 2, endoscopic extraction was abandoned because the impacted fish bone obstructed the entry of the bronchoscope, and a tracheostomy was done. This made the procedure very safe, and laceration and potential permanent injury to the vocal cords and subglottis were avoided.[4]

In Cases 3 and 4, tracheostomy was needed because of the large size of the FB. We had an earlier experience of removing a similar tamarind seed in a five-year-old child by piecemeal removal, which required prolonged muscle relaxation and multiple attempts at bronchoscopy. However, one piece became impacted at the glottis, leading

to respiratory arrest (which could otherwise be successfully managed without any sequelae), and the experience was enough to make us opt for elective tracheostomy if the FB was getting impacted at the glottis due to swelling or obliquity. Hence, in Cases 3 and 4, since repeated bronchoscopic attempts were unsuccessful because the FB was getting stuck at the subglottic area, we opted for removal via tracheostomy. Cylindrical objects (as in Case 3) which are open upwards, tend to tilt laterally when pulled up, and thus the diameter tends to become larger than the original one. Hence, these objects get impacted at the subglottis and may need to be removed through a tracheostomy.[2] Organic FBs (as in Case 4) after aspiration through the narrow subglottic region, sometimes swell in size, precluding retrieval by the same route. Removal by fragmentation is a possibility, but has its own problems and is possible only in vegetable FBs.[7] The subglottic region is the narrowest part of the airway in children. Oedema caused by large diameter FBs may decrease the airway calibre, precluding the removal of FB through this route. It has been reported that the primary suture closure of tracheotomy after the retrieval of the FB, and maintenance of the tracheal intubation for up to five days, can be safely done.[8] However, we prefer to place a tracheostomy cannula for a minimum period, until the patient can safely be weaned. This may leave a scar in the neck but it is a safer option.

Impacted FBs can cause mechanical effects, chemical reactions, and may present as chronic pulmonary infection, bronchiectasis, asthma, lung collapse or lung abscess. A firm impaction of the FB may prevent its removal at bronchoscopy. When this occurs, thoracotomy and operative extraction of the FB become necessary. Whenever possible, this should be done through a bronchotomy with the preservation of the pulmonary parenchyma. The use of a combination rigid and flexible bronchoscope,[9] concurrent chest percussion at bronchoscopy,[10] as well as the use of the Fogarty catheter through the bronchoscopy tube[11] are other methods described for the removal of an impacted FB in the tracheobronchial tree.

A major controversy in the anaesthetic management of patients undergoing bronchoscopy for FB removal is whether to control ventilation or to maintain spontaneous ventilation. There are few studies to justify one technique over the other.[12] The risk of controlled ventilation is forcing the FB deeper into the small airways, and the risk for the spontaneously-breathing patient is his unexpected movement or cough. We administered a short-acting depolarising muscle relaxant, succinylcholine, after ensuring that the patient could be ventilated. Muscle relaxants are used with the aim of abducting the vocal cords for the removal of the FB bronchoscopically. Marks et al summarised the indications of tracheostomy for tracheobronchial FBs thus: acute airway obstruction from a subglottic FB or a FB too large to be removed through the glottis without risking dislodgement and sudden distal obstruction, as well as in avoiding laceration and potentially permanent injury to the vocal cords and subglottis in case of sharp impacted foreign bodies.[4] We recommend its use also in infants with longstanding subglottic foreign bodies with associated granulation tissue that tends to bleed on touch, in order to secure the airway. To conclude, tracheostomy is indicated to secure the airway before attempting FB extraction in certain FBs which are subglottic in location and impacted, or in large FBs that get obstructed at the glottic chink, and to avoid laceration and potentially permanent injury to vocal cords in cases of sharp FBs.

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