

## SUBGLOTTIC STENOSIS: A CAUSE OF DIFFICULT INTUBATION

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STEWART and Pinkerton (1) recently reported a case of unsuspected subglottic (tracheal) stenosis in a 62-year-old adult in whom the diagnosis was made as a result of their inability to pass an endotracheal tube, much smaller than the glottic opening, more than a few centimeters below the cords. Since this report we have had two similar experiences in which previously unsuspected subglottic stenosis was diagnosed as a result of intubation during a routine anesthetic. Both patients were young children who were to have surgery for correction of congenital abnormalities. The purpose of this report is (1) to call attention to what may be an increasingly common problem as more children are routinely intubated for such procedures as tonsillectomy, cardiac surgery, and plastic surgery (2, 3), (2) to discuss the types of subglottic stenosis which may be encountered, and (3) to mention the anesthetic problems which they pose.

### CASE REPORTS

*Patient Number 1.*—An eight-month-male infant weighing 18 pounds was admitted for surgical treatment of tetralogy of Fallot. The infant weighed 8 pounds at birth and was thought to be normal except for a weak cry and a heart murmur. Direct laryngoscopy was performed the day after birth and the mother was told the vocal cords were completely normal. Cyanosis, which increased on crying, first appeared at two months of age. The cry remained weak. The infant had frequent colds and was hospitalized at seven months of age for pneumonia.

On admission the child was fretful, slightly cyanotic, and in some respiratory distress (respiration 72, pulse 152). When crying he made a weak croupy noise, particularly in the sitting position. He preferred lying down at which time his respirations remained rapid but not labored or noisy. There was some suprasternal and intercostal retraction on inspiration. The lungs were clear. The cardiac findings were consistent with the diagnosis of tetralogy of Fallot.

Anesthesia was induced with cyclopropane, nitrous oxide, and oxygen and followed by 10 mg. of succinylcholine intravenously. The larynx was easily visualized and appeared normal. A number 16 French endotracheal tube passed the cords easily but approximately  $\frac{1}{2}$  cm. below the cords, further passage of the tube was not possible. A number 14 French was then tried with a similar result. Ventilation of the lungs was easily accomplished although only the bevel of the tube was below the cords. Progressively smaller tubes were tried until a

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number 10 French slipped snugly beyond the obstruction. A Blalock operation was then performed without incident. At the time of extubation the child was awake and exhibited some inspiratory retraction but not more than peroperatively. The infant was placed in an oxygen tent with humidification. Eight hours following surgery, stridor and increased retraction developed. Tracheotomy was considered. Because of an enlarged liver and pulse rate of 180, the patient was rapidly digitalized. Following this, respiration improved and tracheotomy was deferred. The stridor improved slowly although the weak cry and croupy cough persisted during the postoperative period. Postoperative lateral roentgenograms of the trachea demonstrated an area of subglottic stenosis just below the cords which measured about 1 cm. in length. The remainder of the trachea and the bronchi were of normal caliber. The patient was discharged without other difficulties after ten days.

*Patient Number 2.*—A four-year-old colored male weighing 28 pounds was admitted for repair of a cleft palate. From birth until 6 weeks of age the patient suffered from violent episodes of coughing associated with occasional aspiration of his feedings. At the age of six weeks, his harelip was repaired without difficulty under ether-oxygen insufflation anesthesia without endotracheal tube. Since that time, he had managed his food adequately. Anesthesia was induced with cyclopropane and oxygen and exposure of the larynx, which appeared normal, was accomplished without difficulty. An attempt to pass a number 22 French tube was unsuccessful because of an obstruction below the cords. On closer examination the posterior wall of the trachea, approximately  $\frac{1}{2}$  cm. below the cords, was seen to project into the lumen in a mound-like form and occupied about one half of the tracheal diameter. The surface appeared covered with normal tracheal mucosa. A number 16 French catheter was passed tightly by the obstruction. The surgical repair was performed without incident. Since only slight stridor and retraction were present on extubation, tracheotomy was deferred. However, progressive stridor with retraction and signs of anoxia necessitated an emergency tracheotomy four hours postoperatively. Marked relief of symptoms followed. After three weeks, direct laryngoscopy revealed the subglottic mass still to be present with the same appearance as at the time of the original intubation. The laryngologist thought this to be redundant mucosa. The tracheostomy tube was removed the following day and the patient discharged after 24 hours of observation.

### DISCUSSION

Both children described here presented a history of some type of respiratory difficulty and both were hospitalized for correction of congenital defects. In both, the larynx was easily exposed and appeared normal. Some abnormality was suspected only after the bevel of the endotracheal tube had passed beyond the cords. In each, a much smaller tube than expected was passed only with difficulty. Both developed postoperative stridor and retraction, requiring tracheostomy in one and narrowly avoiding it in the other.

From the paucity of reports, especially in the anesthesia literature, subglottic stenosis would seem to be rare (1, 4-8). The true incidence is probably greater than appreciated since the subglottic area is a region seldom explored by the pathologist at autopsy or by the radiol-

ogist unless specific symptoms lead them there. In addition subglottic stenosis can be symptomless and consistent with long life, as in the patient recently reported (1).

Subglottic stenoses, excluding those caused by inflammation and trauma, are most commonly due to (1) congenital fibrous strictures (4, 6-12), (2) malformations of the tracheal cartilages (4, 5, 8, 11, 16), (3) cardiovascular anomalies such as vascular rings (13), and (4) redundant mucosa (9, 14, 18). In congenital fibrous strictures the area of stenosis may be restricted to a small segment (as in the first patient), or the tracheal lumen may become progressively smaller as the carina is approached (7). Congenital web, a type of congenital fibrous stricture, is a membrane of epithelial and connective tissue which most commonly unites the vocal cords at the anterior commissure. Webs may also occur, however, in the immediate subglottic area or trachea causing variable degrees of stenosis (6, 10-12). Stenoses owing to malformation of tracheal cartilages may result from fusion of the tracheal cartilages posteriorly instead of encircling only four fifths of the trachea, as is normal. With growth of the child, stenosis may develop. Tracheal cartilages may be so soft that localized or generalized collapse of the trachea may result with increased respiratory effort (tracheomalacia). Stenoses resulting from external compression by vascular anomalies are well known and have been extensively reviewed by Holinger (13). Stenosis from redundant mucous membrane leading to respiratory obstruction has been occasionally reported. Our second patient presented this picture.

The anatomy peculiar to the infant larynx complicates this problem for the anesthesiologist. The mucous membrane of the infant is more vascular and more loosely attached than in the adult. When irritated, as with an endotracheal tube, edema of the mucosa develops more readily. Similar degrees of edema compromise the infant lumen more seriously than the adult. In addition, the normal subglottic narrowing in the infant may be as much as 2 mm. in a trachea with a diameter of approximately 8 mm. (12). This relative stenosis occurs beneath the cricoid cartilage, the only cartilage which completely surrounds the trachea and prevents dilatation (2, 6, 12). The size of an infant endotracheal tube thus becomes a function of the subglottic area and not the size of the glottic chink. The importance of the subglottic cross sectional area has been stressed by Eckenhoff (18), who presented two cases similar to those presented here. Eckenhoff implied that his difficulty in intubation was the result of physiologic narrowing at the level of the cricoid. From his case reports it seems more likely that congenital fibrous strictures were present in his patients.

Preoperative recognition of subglottic stenosis may be difficult or impossible since there may be no symptoms resulting from the stenosis or the symptoms present may be considered secondary to cardiac or pulmonary disease (as in the first patient). One might suspect sub-

glottic stenosis in patients with congenital anomalies and a history of respiratory difficulties. The association of tracheal stenosis with other congenital anomalies is more than casual. Five of the 11 patients reported by Wolman had more than one anomaly (7).

At the end of the operation, the important question of elective tracheotomy arises. The possibility that the stenosis is of the funnel type as described by Wolman, makes it imperative that this be ruled out before the tracheotomy is done. With a funnel type stenosis tracheotomy may be impossible or, if attempted, fatal (7). Lateral roentgenograms should be taken of the neck and chest with shoulders held back and head extended to visualize the complete airway. If possible inspiratory and expiratory films should be taken (5, 17). If the stenosis is localized, we believe tracheotomy should be done before removal of the endotracheal tube.

### SUMMARY

Case reports of two patients with previously unsuspected subglottic stenosis are presented. Both occurred in children undergoing surgery for correction of congenital defects and were diagnosed only after difficulty was encountered in passing the usual endotracheal tube beyond the subglottic area. The anatomy peculiar to the infant larynx and the types of subglottic stenoses are reviewed. The commonest type, localized congenital fibrous stricture, may be symptomless or symptoms may be attributed to other diseases. Stenosis encountered during intubation should be confirmed radiologically at the end of the operation and if localized, immediately tracheotomy is recommended. It is anticipated that subglottic stenosis may be an increasingly frequent problem as more children are intubated for routine anesthetics.

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