Necrotizing Tracheobronchitis Identified on an Indium-111-White Blood Cell Scan

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The clinical entity of necrotizing tracheobronchitis (NTB) is well described in the pediatric literature (1-4). The incidence of NTB in neonatal autopsies varies from 4% to 44%. More than 3 hr of assisted ventilation may be necessary for the development of NTB in neonates (1). A similar clinical problem was described as "hemorrhagic tracheitis" in two adults during high frequency jet ventilation and as a complication of conventional mechanical ventilation in an adult. We present here a rather unusual case of NTB in an adult on mechanical ventilation, in whom tracheobronchitis was diagnosed incidentally with an $^{111}$In white blood cell scan obtained for other purposes.


Necrotizing tracheobronchitis (NTB) has been reported as a complication of conventional ventilation (1, 3-5), high rate conventional ventilation (2), and high frequency ventilation (3) in newborns/infants with respiratory failure. NTB is characterized by replacement of normal tracheal mucosa with acute inflammatory cells, mostly neutrophils. In addition, the airway lumen often contains necrotic debris. This lesion has been associated with life-threatening airway obstruction and death despite bronchoscopy in 45% of the patients reported (2-5).

CASE REPORT

A 60-yr-old white female presented with complaints of nausea, vague abdominal pain and a single episode of vomiting. On initial evaluation, the patient was found to be in diabetic ketoacidosis. Two days after admission, the patient experienced a febrile episode, an episode of rigor and some discomfort in the left knee and hip. The patient developed distension of abdomen and increasing left gluteal tenderness. Despite numerous negative cultures, her course was that of septic shock, and she was covered with multiple antibiotics. The left gluteal area was surgically explored and this revealed a necrotic gluteus medius muscle, which was excised and debrided.

One week after admission, the patient began to develop respiratory failure, for which she was intubated and later placed on a mechanical ventilator. The patient was kept on mechanical ventilation for approximately ten days.

Approximately two weeks after admission, an $^{111}$In-labeled WBC scan was done to search for an occult source of infection. The WBC scan, obtained 24 hr after intravenous injection of $^{111}$In-WBCs, demonstrated increased activity in the left gluteal area, consistent with postoperative diagnosis of fascitis and myositis. There was also increased WBC activity throughout the thoracic trachea, the main stem bronchi and perihilar regions bilaterally consistent with tracheitis and pulmonary inflammation (Fig. 1). Bronchoscopy was performed, which revealed extensive mucous plugging of the bronchi.

The patient's status continued to deteriorate, and she died due to multisystem failure. At autopsy, cut sections of lungs, trachea and bronchi tree showed bronchi filled with extensive gray and white mucous plugs and extensive ulceration of all bronchi and the trachea. Sectioning of the trachea revealed extensive denudation of the mucosal surface which was covered by a thick fibrin meshwork containing fibrin strands and both viable and degenerating PMN leukocytes. These pathologic findings are diagnostic of necrotizing tracheobronchitis.

DISCUSSION

NTB has been defined as a "necrotic inflammatory process involving the main stem bronchi and the distal trachea in neonates requiring mechanical ventilation. This process results in sloughing of respiratory epithelium with resultant occlusion of the distal trachea" (3). At least 3 hr of assisted ventilation are necessary for the development of NTB in neonates (1). A similar clinical problem was described as "hemorrhagic tracheitis" in two adults during high frequency jet ventilation (6) and in a single adult as a complication of conventional mechanical ventilation (7).

The exact etiology of NTB remains unclear. Mammel et al. (8) noted that tracheal injury occurred with both high rate conventional ventilation and jet ventilation, but that the highest respiratory rate seems to produce the most damage. He concluded that ventilator frequency may be responsible for the tracheal injury (8). In a study of infants dying after conventional and high frequency jet ventilation (HFJV), Boros (9) noted that HFJV was associated with significantly more airway damage than was conventional ventilation.

In contrast Hanson et al. (10) identified tracheal ischemia as a major cause of NTB, in addition to mechanical ventilation. Hypoxia, hypotension, sepsis or shock were significant underlying causes of tracheal ischemia, and
FIGURE 1. WBC scan study with $^{111}$In after 24 hr of delay. Anterior view of thorax. Evidence of increased WBC activity is seen in the thoracic trachea, the main stem bronchi and perilobar regions of lungs bilaterally.

several of these factors were present in our patient. The most commonly affected anatomic regions of the trachea in Hanson’s series was the middle or thoracic trachea, which was seen in 56% of cases. Involvement of other areas varied with 20%, 15% and 9% for the cervical trachea, carina and main stem bronchi, respectively. Whether or not the anatomic location seen in neonates will apply to adult patients is uncertain. Certainly the case presented here was unusually extensive by neonatal standards.

In the absence of a single identifiable cause for NTB, therapy has been directed almost exclusively at relieving the symptomatic respiratory obstruction by repeated bronchoscopies. The intratracheal instillation of heparin and urokinase has been attempted, but clinical experience is too limited to draw any conclusions (5).

Indium-111-leukocytes provide a relatively specific and sensitive marker for cellulitis, abscesses, acute osteomyelitis, infected arthroplasties, prosthetic vascular grafts or other inflammatory conditions. The test is easy to perform, safe, requires minimal patient cooperation and is widely available for evaluation of patients with systemic or localizing signs suggestive of inflammation. The utility of $^{111}$In-labeled leukocytes scintigraphy in patients with occult infection is illustrated by the experience of Baldwin and Wright (11). The sensitivity and specificity of $^{111}$In WBC scanning in their series was 97% and 91%, respectively, with an overall accuracy of 94%.

Despite these excellent overall results, WBC scanning of the lungs has proven to be difficult to interpret. Usually, WBC activity clears from the lungs within 4 hr of injection, but prolonged diffuse or focal uptake may be seen for a wide variety of reasons (12,13). While the sensitivity of a positive pulmonary WBC scan is very high, the specificity of diffuse pulmonary uptake is low and that of focal pulmonary uptake is variable, ranging from 52% to 100% (13,14). Attempts to improve specificity may result in a lower sensitivity (13-15).

Normal tracheal WBC activity has not been reported, although it is frequently present in tracheostomy sites, and may be considered to be a normal variant when a tracheostomy is present (14). The sensitivity and specificity of tracheal WBC activity for inflammatory processes has not been evaluated.

Since NTB is characterized by replacement of normal tracheal mucosa with acute inflammatory cells, mostly neutrophils, $^{111}$In-WBC scan may be helpful in identifying and following the patients with NTB. Specifically, as NTB is frequently clinically silent (10), the condition may first be suspected from the findings present on a WBC scan obtained to evaluate a septic patient. If NTB is suspected clinically, urgent bronchoscopy to confirm the diagnosis and relieve any tracheobronchial obstruction would be a more appropriate course of action.

The potential usefulness of $^{111}$In-WBC scanning for detecting NTB is illustrated in this case report. The striking visualization of the trachea, the main stem bronchi and perilobar regions of the lungs produces an appearance which is rather unique and may allow a relatively specific diagnosis of NTB to be made, particularly when combined with a history of mechanical ventilation. Differentiation from esophagitis may, however, prove to be difficult in cases showing only tracheal localization of $^{111}$In-WBCs. Further evaluation with a larger number of cases will be needed to define the value of $^{111}$In-WBC scanning for detecting, evaluating the extent of and following the course of NTB.

CONCLUSION

Although a frequent complication of mechanical ventilation in the neonate, NTB as a complication of conventional mechanical ventilation has been recognized only rarely in adults (7). While the presentation of NTB is often occult, NTB should be suspected in adults who have had mechanical ventilation and who are experiencing ventilatory difficulties after routine problems have been treated or excluded. NTB is not a universally fatal disease. Prompt recognition and immediate treatment of obstruction may be life saving. Indium-111-WBC scanning may be of benefit in the noninvasive diagnosis and evaluation of this condition by confirming a clinical impression or by detecting an occult presentation, but the definition of the clinical role that this procedure should fill will need to await the results of more extensive experience with $^{111}$In-WBC scanning in this patient population.

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REFERENCES

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Necrotizing Tracheobronchitis • Desai and Yuille