TRACHEAL STRICTURE

ADDENDUM

The authors feel that this observation is of interest and might be worthwhile exploring further. It should be clearly understood that edrophonium chloride is not recommended as a primary or a preferred method of therapy for the abolition of atrial flutter. For this purpose, the use of digitalis, electric countershock and other means would be indicated.

REFERENCES


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Tracheal Stricture Secondary to Cuffed Tracheostomy Tubes*

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Tracheal strictures have been seen with increasing frequency concomitant to increased usage of cuffed tracheostomy tubes. A patient with such a stricture following aortic valve replacement is described. The possible contributory mechanisms in tracheal stricture include: (1) excessive cuff inflation; (2) disturbance of vascular supply to tracheal mucosa; (3) infected secretions above the cuff; (4) piston force of respirator, and (5) other shear forces along the cuff-mucosa interface. Measures to prevent stricture formation are highly disputable. Operative intervention at an early date is the ideal form of treatment in strictures not responding to nonoperative measures.

Prior to widespread use of cuffed tubes, post-tracheostomy strictures were reported infrequently.1-5 However, during recent years, the incidence of tracheal strictures has increased paralleling the more liberal use of cuffed tubes and respirators principally in treatment of cases of trauma, respiratory insufficiency and cardiac surgery.6-10 The difficulties in management of such a stricture are well illustrated in the following case report.

CASE REPORT

A 42-year-old man underwent aortic valve replacement for severe aortic insufficiency on February 24, 1967. No significant problems were experienced during the intraoperative or immediate postoperative periods. Tracheostomy, using a metal tube and separate cuff, was performed on the second postoperative day because of excessive secretions. Forty-eight hours later, respiratory and cardiac arrest occurred secondary to tracheal obstruction caused by dislodgment of the tracheostomy cuff. The resultant cerebral hypoxia necessitated the use of a mechanical ventilator continuously for the next several days and intermittently thereafter until the tracheostomy tube was removed on the 21st postoperative day. Recovery from cerebral damage was complete and cardiac function remained excellent. However, one month later, the patient experienced increasing respiratory distress shown by bronchoscopy to be due to a cuff-level stricture of the trachea (Fig 1). During the ensuing eight months, a conservative approach to manage the tracheal stricture was followed and resulted in eight hospital admissions, 16 bronchoscopies with dilatation or attempts at endoscopic removal of the stricture, four additional tracheotomies and one incomplete resection. Dilatations were carried out with graduated long tracheostomy tubes, bronchoscopes or small esophageal dilators. Two short courses of high dosage steroid therapy were without apparent benefit. Stricture removal was attempted with endoscopic forceps (one episode while patient was anticoagulated resulting in severe hemorrhage), chemical cautery (potassium hydroxide pellets) and electrical cautery. One attempt at cautery using a fine wire loop resulted in entry into the innominate artery with massive intratracheal bleeding controlled by tamponade via a pediatric endotracheal tube inserted through a hastily reopened tracheostome. Definitive resection and reanastomosis (Fig 2) following wide mobilization through the reopened median sternotomy was performed.

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Figure 1. Bronchogram showing severe narrowing of trachea at level of previously used tracheostomy cuff. Contrast medium is being injected into tracheostome through a small plastic catheter.
ten months after the original cardiac surgery, and the patient has been asymptomatic since. Length of total tracheal excision (definitive resection plus previous incomplete resection) was five rings.

**Recapitulation**

Initial therapeutic efforts were limited to dilatation because of the experience cited by Johnston et al.\textsuperscript{16} with non-resective management. Resection and reanastomosis via limited sternotomy and cervical approach failed probably because of lack of adequate mobilization of the distal trachea. Undoubtedly, undue tension on the suture line resulted in anastomotic disruption and stricture recurrence. Definitive resection was facilitated by radical mobilization of the entire length of trachea on its anterior and lateral aspects as described by Pearson et al.\textsuperscript{17} Blood supply was preserved by leaving the posterior wall undisturbed except for a short distance on either side at the level of resection. Incision of the pericardium posterior to the ascending aorta and right pulmonary artery gave excellent exposure of the carina and both main bronchi. Mobilization of the right interior pulmonary ligament aids in releasing tension on the distal trachea. Anastomosis with multiple interrupted sutures and without tension provides primary healing in most instances.

**Conjectural Considerations**

Post-tracheostomy strictures most likely result from interruption of the intact mucosal barrier and coincident submucosal or full wall thickness infection (Fig 3). Ischemia of the poorly vascularized cartilaginous rings also may be an important factor. Continuous cuff inflation even with periodic cuff deflation may be responsible for the following contributory mechanisms: (1) pressure necrosis (excessive cuff inflation); (2) vascular disturbance (obstruction to mucosal arterial inflow or venous return); (3) blind pocket above cuff where infected

![Figure 3A. Gross photograph of resected stricture. Airway lumen is four millimeters. Figure 3B. Microscopic section of specimen showing relatively normal wall thickness where mucosa is intact and severe cicatricial thickening where mucosa is missing.](image)
TRACHEAL STRicture

Figure 4. Although many secondary etiologic factors are concerned with stricture formation, combination of loss of mucus barrier and infection remains most important.

secritions may not be accessible to suction removal (Fig 4). Shear forces along the cuff-mucosa interface may be produced by: (1) piston-like force of respirator; (2) swallowing or excessive neck movements by patients (especially common in patients with mental confusion); (3) voluntary or provoked coughing.

Shelly et al have demonstrated clearly the importance of degree and duration of pressure within the cuff in stricture formation. Pearson et al and Cooper and Grillo have outlined the salient features in pathogenesis, clinical evaluation and therapeutic approach to tracheal strictures.

Discussion

Prevention of stricture formation will continue to be of paramount importance until "fail-safe" cuffed tubes and respirator systems are available. Cuff over-inflation is to be avoided at all costs. This is most readily accomplished by carefully identifying and recording the amount of air required to fill the cuff optimally and never exceeding this figure. Change in location of cuff pressure at regular intervals has been suggested either by using double cuffed tubes or improvisation. Tubes with two cuffs appear much too bulky, may double the chance of stricture formation, and may actually obstruct a main bronchus at the carina because of excessive length. Cuff inflation synchronous with respiration has been described and may decrease the risk of stricture.

The addition of an inflatable cuff to the tracheostomy tube has been of considerable benefit primarily because of the absolute control of pulmonary ventilation that it affords. The hazard of separate cuff dislodgment has been circumvented by the introduction and widespread use of a single unit. However, this has been accom-

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Selective Coronary Arteriography*

Use of Judkins’ Catheters via the Brachial Artery

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Evidence and accumulated experience are presented which indicate that the widely-used Judkins’ technique for the performance of selective coronary arteriography can be safely accomplished through the brachial artery. This modification eliminates the inconvenience caused by using separate sites (arm and leg) at any one sitting for routine cardiac catheterization and the additional performance of selective visualization of the coronary tree. It also allows for these studies in the patient with occlusive serto-femoral disease in whom passage of catheters via the femoral artery is associated with high risk or cannot be accomplished. The variation is safe and as quick as other methods.

Selective coronary arteriography has been accepted as a safe procedure for the definitive diagnosis of disease of large and medium-sized coronary arteries. In the past, the performance of this procedure has required considerable skill and experience in the use of catheter techniques. With the introduction of newer, pre-shaped catheters, cannulation of the coronary vessels has become simpler and this technique has done much to popularize selective coronary arteriography in catheterization laboratories throughout the world. Commonly, right and left heart catheterization and associated angiographic procedures are performed via the brachial approach, and if, in addition, coronary arteriography is indicated, it would be desirable and more convenient for the physician to perform the entire study through the same approach. We have now attempted this approach in 20 patients. We have found it satisfactory and have been able to obtain good quality coronary angiograms with ease equal to a femoral approach. This report describes our experience in these cases.

MATERIAL AND METHODS

The procedures are performed using standard Judkins’ catheters. Initially the left arm approach was used, but the last 18 cases have been performed from the right arm. A cut-down is made in the usual fashion exposing the brachial artery in the antecubital fossa. The right coronary catheter is introduced without a wire. The left coronary catheter is inserted into the arteriotomy with the wire inside, the flexible end of the wire lying just within the tip of the catheter. On reaching the proximal aorta, the wire is immediately withdrawn and the catheter flushed several times. Continuous pressure and electrocardiographic monitoring are accomplished using a multi-channel recorder.*

The catheter is guided fluoroscopically in the usual manner. After engaging the coronary ostia, multiple hand injections of 8-10 ml of opaque media are made into each coronary artery in the right and left anterior oblique positions. Frequent observation of the tip of the catheter is necessary in order to avoid excessive penetration of the catheter into the coronary vessels, particularly the left. In most of our cases, a "C" arm arrangement was utilized so that the x-ray tube was placed in the oblique position without the need for turning the patient. In the remainder, a conventional overhead-under-the-table tube was used. Most frequently, the catheter was left in the proximal coronary vessel, although it was removed and replaced in the next oblique position if necessary.

RESULTS

Twenty separate procedures have been performed via the brachial artery, 18 from the right and two from the left. In every instance it was possible quickly to engage the right and left coronary ostia. There were no complications other than sinus bradycardia following the injection of opaque media and this was reversed quickly by having the patient cough repeatedly and by the use of atropine sulfate, gr. 1/150 intravenously.

Position of the catheters in the proximal aorta (Fig 1) and the quality of angiograms was in no way different from those performed transfemorally. The time consumed in the performance of the study was similar for either approach. There was no difference in the ease with which a study could be performed from either arm. When the coronary angiograms were performed as part of the right and left heart catheterization, they were done as the last procedure because of the 8 French diameter of the Judkins’ catheters (since No. 7 catheters are routinely used for the right and left heart catheterization, if the No. 8’s were to be used first, leakage of blood from the stretched arteriotomy site would be ex-

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