Blunt tracheobronchial injuries: treatment and outcomes
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Blunt Tracheobronchial Injuries: Treatment and Outcomes

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Background. Tracheobronchial injury is a recognized, yet uncommon, result of blunt trauma to the thorax. Often the diagnosis and treatment are delayed, resulting in attempted surgical repair months or even years after the injury. This report is an extensive review of the literature on tracheobronchial ruptures that examines outcomes and their association with the time from injury to diagnosis.

Methods. We reviewed all patients with blunt tracheobronchial injuries published in the literature to determine the anatomic location of the injury, mechanism of the injury, time until diagnosis and treatment, and outcome. Only patients with blunt intrathoracic tracheobronchial traumas were included.

Results. We identified 265 patients reported between 1873 and 1996. Motor vehicle accidents were the most frequent mechanism of injury (59%). The overall mortality among reported patients has declined from 36% before 1950 to 9% since 1970. The injury occurred within 2 cm of the carina in 76% of patients, and 43% occurred within the first 2 cm of the right main bronchus. The proximity of the injury to the carina had no detectable effect on mortality. Injuries on the right side were treated sooner but were associated with a higher mortality than left-sided injuries. No association was detected between delay in treatment and successful repair of the injury; ninety percent of patients undergoing treatment more than 1 year after injury were repaired successfully.

Conclusions. This review of patients with blunt tracheobronchial injuries represents the largest cohort studied to date. These data suggest an ability to repair tracheobronchial injuries successfully many months after they occur. We are also able to assess the mortality associated with the location and side of injury, examine the time from injury until diagnosis and treatment, and evaluate treatment outcome.

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The National Safety Council published a report in 1983 estimating that 25% of all blunt trauma deaths were due to thoracic trauma [1]. However, little information is available concerning the incidence of injury specifically to the trachea or the bronchus as a result of blunt trauma. One reason for this may be that nearly 80% of patients with blunt traumatic injury to the trachea or bronchus die before arriving at a hospital and, therefore, go unreported [2]. In a review of 1,178 trauma autopsy reports, only 33 patients (2.8%) of tracheobronchial rupture were identified, and 81% of these patients died before reaching the hospital [3]. Another study of 585 patients who died from motor vehicle accidents over a 10-year period identified only 5 patients with tracheobronchial injuries, or less than 1% [4]. Four of these 5 patients died at the scene.

One of the earliest accounts was published in 1873 by Seuvre [5], who described a 74-year-old woman found to have a right main stem bronchus avulsion at autopsy after her chest was crushed by a wagon wheel. Since this description was published, the common mechanism of injury has changed from crush injuries to deceleration injuries involving high-speed motor vehicle accidents. Despite the change in the mechanism of injury, the nature of injuries encountered has remained essentially the same, and rupture of the trachea or bronchus remains the most common type of blunt airway injury. Despite an increased awareness of this type of injury, it is not uncommon for the diagnosis to be made weeks or months after the injury occurs.

Patients who suffered blunt tracheobronchial injury were the focus of our study. We performed an extensive review and analysis of the literature, and we added one case from our institution that had not been previously reported.

Case Report

A 28-year-old man was in good health until a 2.5-ton load of steel rods fell on his right chest and leg. He had several fractures, an associated right pneumothorax, and a pulmonary contusion. During his extended course in the intensive care unit, he experienced recurrent mucus plugging on the right and a persistent right superior pneumothorax, despite having a right chest tube placed on admission and a second tube placed 11 days later. Two weeks after the injury he underwent bronchoscopy that demonstrated narrowing of the right main stem orifice secondary to granulation tissue in the airway. He was taken to the operating room 1 month after injury because of a persistent right pneumothorax. The right middle and lower lobes were difficult to expand during the operation,
but no other pathology was noted. He improved slowly, tolerated removal of his chest tubes, and was discharged, although the right lung remained poorly expanded.

Over the next 4 months, he remained short of breath. Pulmonary function tests demonstrated a forced expiratory volume in 1 second of 50% predicted and a forced vital capacity of 42% predicted. He was then referred to our institution and a bronchoscopy revealed a completely occluded right main bronchus. A ventilation/perfusion scan revealed good perfusion of the right lung despite lack of ventilation. He underwent a right thoracotomy more than 6 months after the injury, which revealed complete transection of the right main bronchus. Granulation tissue and scar had completely occluded the airway, filling in between the two ends of the bronchus, which were separated by approximately 1 cm. A sleeve resection of the right main stem bronchus and decortication were performed. He tolerated these procedures well and was discharged 10 days later with a fully expanded and well-aerated right lung. His pulmonary status improved, and repeat pulmonary function tests at 4 months demonstrated a forced expiratory volume in 1 second of 60% predicted and a forced vital capacity of 54% predicted. He continues to do well 4 years after his repair with a forced expiratory volume in 1 second of 77% of predicted and a forced vital capacity of 71% of predicted.

Material and Methods

We performed a thorough review of the literature published between 1873 and 1996, identifying all patients reported with blunt tracheobronchial injuries. This included all reports listed in Medline (using key words: trachea, bronchus, blunt, injury), as well as all other cases that could be identified from listed references in published articles.* We limited the study to patients with intrathoracic tracheal or bronchial injury, excluding those with cervical injuries. Collected information included mechanism of injury, time until diagnosis and treatment, anatomic location of injury, type of treatment, duration of follow-up, method of diagnosis, and outcome. Patients with bilateral bronchial injuries were excluded from injury location analysis. Time until diagnosis and time until treatment were defined as the reported time from injury until the diagnosis was clearly established or until definitive treatment occurred. We considered operative treatment to be administered if a patient underwent pulmonary resection or surgical repair of a tracheobronchial injury. Cases involving only conservative treatment (e.g., placement of a chest tube) or no treatment (e.g., autopsy findings) are not included in the analyses of time until treatment. Patients were considered to have had a successful surgical outcome if the authors reported subjective or qualitative improvement after surgical repair of a tracheal or bronchial injury or after pulmonary resection. Patients were classified as dead if the authors reported that the patient died due to tracheobronchial or associated injuries or died during treatment.

Statistics

We assessed the statistical association between patient demographic and clinical characteristics and several outcomes. Comparisons involving time until diagnosis, time until treatment, and distance from injury to carina were evaluated using the Wilcoxon rank sum statistic. Associations between death from tracheobronchial injury and patient age, era, time until diagnosis, and time until treatment were assessed using a Mantel-Haenszel chi-square test for trend. Associations between death from tracheobronchial injury and injury location, treatment, and mechanism of injury were assessed using an ordinary chi-square statistic. To explore the relationship between the variables in a manner that controls for confounding, we fit a multivariable logistic regression model using death from tracheobronchial injury as the outcome. Covariates comprised dummy variables for era (before 1950, 1950 to 1969, after 1970), days to diagnosis (1, 2 to 7, > 7), side of injury (left, right), type of treatment (none or nonoperative, repair, resection) plus interactions to allow the effect of repair to differ for tracheal and bronchus injuries.

Results

Demographics, Cause of Injury

A total of 265 patients with blunt tracheobronchial injury were collected, including the patient reported here and all other patients published in the literature. The demographics and clinical characteristics of the patients are reported in Table 1. Patient ages ranged from 1 to 74 years, with a median age of 20 years. More than half of the injuries (54%) involved persons between 10 and 29 years of age. The distribution of injuries reported by year demonstrated that only 96 patients (36%) were reported since 1970.

A determination of the causes of injury showed that motor vehicle accidents accounted for the majority of patients (59%), followed by crush injuries (27%). Since 1970, injuries secondary to motor vehicle accidents occurred more frequently. The percentage of patients with tracheobronchial injuries due to motor vehicle accidents increased from 34% before 1950 to 67% since 1970.

Location of Injury

Right-sided bronchial injuries occurred most frequently as found in 47% of the 259 patients for which side of injury was documented (Table 1). Injury to the trachea and left main bronchus occurred less frequently. Five patients with bilateral bronchial injuries are reported in the literature [6–10]. Three of these patients also had tracheal involvement [6–8]. All 5 patients were diagnosed within the first 24 hours of injury, but 3 patients died as a result of their injuries. These 5 patients are not included in the statistical analyses involving injury location because of the complexity of their bronchial injury.

A summary of 88 patients with documentation of the exact location of injury is shown in Figure 1. Rupture occurred within 1 cm of the carina in 58% of these

*Contact the authors for a complete list of references.
patients and within 2 cm of the carina in 76%. Approximately half (41 of 88) of these reported injuries involved the right main bronchus. Thirty-eight of the 88 injuries (43%) occurred within the first 2 cm of the right main bronchus. The average distance from the location of injury to the carina was shorter for right bronchial injuries than for left bronchial injuries (1.1 cm [standard error 0.17] versus 1.8 cm [standard error 0.19], p = 0.001). This difference may result from the longer length of the left bronchus compared with the right.

### Time Until Diagnosis and Treatment

The median time until diagnosis and surgical treatment was 9 days and 25 days, respectively. Left-sided injuries took longer to diagnose and treat than right-sided or tracheal injuries (Table 2). In patients for whom the side of injury and the time until diagnosis or time until treatment, or both the time until diagnosis and treatment, were reported, the median time to diagnose ruptures of the left main bronchus was 30 days (mean = 573 days). This compares with a median of 1 day (mean = 161 days) for diagnosis of right-sided injuries (p = 0.001) and 3 days (mean = 24 days) for tracheal injuries (p = 0.001). Among patients treated surgically, the median time until treatment was 42 days (mean = 841 days) for patients with left-sided injuries compared with 3 days (mean = 68 days) for patients with right-sided (p = 0.001) and tracheal injuries (p = 0.051), respectively.

An immediate diagnosis (within 24 hours) was accomplished more frequently in right-sided injuries. Fifty-two percent of patients with right-sided bronchial injuries were diagnosed within 24 hours of injury, whereas only 14% of patients with left-sided bronchial injuries and 43% with injuries limited to the trachea were diagnosed within 24 hours. Injury to the right bronchus occurred in 66% of patients diagnosed within 24 hours with unilateral injuries for whom location of injury data was available. The predominance of right-sided injuries in patients diagnosed immediately was consistent when analyzed separately by decade of injury.

### Mortality of Injury

A univariate analysis of variables predicting death is presented in Table 3. Although the patient’s age was not significantly associated with death (p = 0.197), the location of the injury, the era of the case report, the time until diagnosis, the mechanism of injury, and the type of treatment were all significant variables associated with death.

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Table 1. Demographic and Clinical Characteristics of Reported Cases

<table>
<thead>
<tr>
<th></th>
<th>Since 1970</th>
<th>All Cases</th>
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<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
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</tr>
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<td>Age at diagnosis (yrs)</td>
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<td>0–9</td>
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<td>18</td>
</tr>
<tr>
<td>10–19</td>
<td>25</td>
<td>31</td>
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<td>20–29</td>
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<td>30+</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Missing</td>
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</tr>
<tr>
<td>Year of diagnosis</td>
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<tr>
<td>1870–1949</td>
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<td>1950–1969</td>
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<td>.</td>
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<tr>
<td>Missing</td>
<td>.</td>
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</tr>
<tr>
<td>Cause of injury</td>
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<tr>
<td>Motor vehicle accident</td>
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<td>67</td>
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<tr>
<td>Crush</td>
<td>18</td>
<td>20</td>
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<tr>
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<td>13</td>
</tr>
<tr>
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</tr>
<tr>
<td>Site of injury</td>
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<td></td>
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<tr>
<td>Right bronchus</td>
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<td>64</td>
</tr>
<tr>
<td>Left bronchus</td>
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<td>22</td>
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<td>Trachea</td>
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<td>11</td>
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<tr>
<td>Missing</td>
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<td>.</td>
</tr>
</tbody>
</table>

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Table 2. Diagnosis and Treatment of Tracheobronchial Injuries Relative to Side of Injury

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Right</th>
<th>Trachea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>83</td>
<td>122</td>
<td>49</td>
</tr>
<tr>
<td>Median days until diagnosis range (1 day–23 yrs) (1 day–21 yrs) (1 day–1 yr)</td>
<td>30</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Median days until treatment range (1 day–34 yrs) (1 day–15 yrs) (1 day–1 yr)</td>
<td>42</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>Diagnosed ≤ 24 hrs after injury %</td>
<td>14%</td>
<td>52%</td>
<td>43%</td>
</tr>
</tbody>
</table>

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![Fig 1. Number of patients and injury location in 1 cm increments from the carina.](image-url)
Patients with left-sided injury had a more favorable outcome than patients with right-sided or tracheal injuries. The overall mortality for patients with left-sided injuries was 8%, compared with 16% in patients with right bronchial ruptures ($p = 0.004$) and 26% in patients with ruptures of the trachea ($p = 0.009$). Five patients with bilateral bronchial injuries were reported. Three (60%) of these patients died. The lower mortality associated with left-sided injuries was not as evident among patients diagnosed immediately. In fact, the location of injury was not associated with the mortality rate for patients diagnosed within 24 hours (right side = 24%; left side = 18%; tracheal injuries = 21%; $p = 0.899$).

An improvement in the mortality rate since 1950 was demonstrated by examination of the reports of the 237 patients for whom the overall mortality and year of diagnosis were documented (Table 3). The mortality rate decreased from 36% before 1950 to 9% since 1970 ($p < 0.001$). The time until surgical treatment of tracheal or bronchial injuries also decreased since 1950 ($p = 0.001$). The median time until treatment before 1950 was 120 days (<1 day–11 years) compared with the median delay of 42 days (<1 day–34 years) between 1950 and 1970, and 1 day since 1970.

The mortality was higher for patients diagnosed and treated earlier in their course of disease. Eighty-nine patients were diagnosed and 64 were treated surgically within 24 hours of injury. Among the 22 patients who were diagnosed within 24 hours of injury and died, six deaths occurred during or after surgical therapy. The death rate remained high (40%) for those patients diagnosed during the first week after injury. Of the 116 patients diagnosed more than 7 days after injury, only 3 patients (3%) died; all 3 of these patients had been treated surgically. The difference in mortality of patients diagnosed within 24 hours and those diagnosed 2 to 7 days after injury was not significant ($p = 0.111$). The difference of each of these groups compared with patients diagnosed more than 7 days after injury was significant ($p = 0.001$ for each group).

The increased early mortality can be attributed to associated injuries rather than to the airway injury itself. Of the nine deaths among patients who were treated surgically within 7 days of injury, 4 deaths could be directly related to other associated injuries. Causes of death included multisystem organ failure, septic and hemorrhagic shock, and cardiac arrest. Furthermore, four of the remaining five mortalities that occurred either intraoperatively or in the immediate postoperative period appeared to be indirectly related to other (nonairway) traumatic injuries.

The chance of death from tracheobronchial injury was significantly related to the mechanism of injury ($p = 0.015$). Deceleration injuries (ie, motor vehicle accidents and falls) were associated with a better chance of survival (87%) than crush injuries (73%). Of the 39 deaths reported in the literature, 18 patients (46%) were injured by rapid deceleration.

### Treatment Outcome

Patients with either tracheal or bronchial injuries had a better outcome if they underwent surgical repair or pulmonary resection than if they were not treated or treated with more conservative measures (Table 3). The mortality rate of patients who underwent repair of bronchial injuries was lower than that of patients who underwent resection of the injured bronchus and distal lung parenchyma (3% vs 13%; $p = 0.001$). Among the four bronchial injuries that were treated conservatively, one patient died. Sixty-seven percent of untreated bronchial injuries resulted in death. The patients with injury to the trachea who underwent surgical repair of the injury had only a 6% mortality, compared with a 66% mortality (2 of 3).
in the patients managed conservatively and a 73% mortality (8 of 11) in patients not treated (p = 0.001).

Delay in treatment was not associated with the rate of successful surgical repair of the tracheobronchial injury. Patients who underwent repair of tracheobronchial rupture within 7 days of injury had a 77% chance of successful repair, whereas those who underwent repair 2 months to 1 year after injury had a 90% success rate (Table 4). Even among 9 patients with repairs done more than 1 year after injury, 89% had a successful outcome. The location of the injury also had no significant effect on the rate of successful repair. Unfortunately, objective pulmonary function tests were available in only 5 patients: 3 patients demonstrated improvement, and 2 patients demonstrated no change after repair. Those patients who did not have the injury repaired, but underwent pulmonary resection instead, had similar survivors; however, they did lose lung tissue that may have actually been functional.

Multivariate Analysis
All factors with a p less than 0.1 in the univariate analysis except mechanism of injury were entered into a multivariate model to assess which factors had independent prognostic significance (Table 3). Mechanism of injury was not included because the sample sizes were insufficient when all other variables were included in the analysis. Time until diagnosis and type of treatment were highly significant independent predictors of mortality. Diagnosis after 7 days was associated with a 10-fold reduction in the odds of death compared with patients diagnosed within 24 hours (p < 0.001). Patients undergoing surgical repair of the trachea had a 10-fold reduction in the odds of death compared with tracheal injuries treated conservatively or not at all (p = 0.010). The reduction in odds for patients undergoing bronchial repair was greater than 10-fold (p < 0.001), and patients undergoing lung resection experienced a fivefold reduction in the odds of death compared with patients with untreated lung injuries (p = 0.046). These results may reflect the fact that many of the untreated patients died before surgical treatment could be administered. Among patients undergoing surgical repair, both left- and right-side bronchial injuries were associated with lower odds of death than tracheal injuries, but these differences did not reach statistical significance (Table 3). In contrast, for patients receiving no surgical treatment (data not shown), right-side bronchial injuries were associated with an estimated fourfold increase in the odds of death compared with tracheal injuries, but the estimates did not reach statistical significance (p = 0.093). Left bronchial injuries were associated with an estimated twofold increase in the odds of death, but this result was also not significant (p = 0.331).

Comment
Although injury to the tracheobronchial tree is seen infrequently after blunt trauma, reports of such injuries are not new to the literature. Winslow [11] published the earliest report of an injury to the bronchus in 1871. While preparing a wild duck after a hunt, he discovered that the duck’s left main bronchus had been ruptured at the carina. The duck had survived that acute injury, apparently for several months, until “his recovery was interrupted by a hunter.” In 1873, Seuvre [5] described a 74-year-old woman with right main bronchus avulsion discovered at autopsy. In 1931, Nissen [12] described a successful pneumonectomy in a 12-year-old girl with a posttraumatic stricture of the left main bronchus. Later, in 1949, Griffith [13] reported a patient with primary sleeve resection and repair of a posttraumatic stricture of the left main bronchus.

Three theories have been proposed regarding the exact mechanism of injury to the trachea and bronchi [3, 14]. The first associates tracheobronchial disruption with a sudden, forceful compression of the chest, decreasing the anterior-posterior diameter of the chest while widening the transverse diameter. In this scenario, the lungs remain in contact with the chest wall and the lateral forces pull the lungs apart at the carina. This may be the dominant mechanism involved in crush injuries, although the elasticity of the lungs should diffuse any retractile forces experienced at the carina during chest wall retraction. The second theory involves compression of the chest and trachea while the glottis is closed. This produces a rapid increase in airway pressure, especially in the trachea and larger bronchi. When the pressure exceeds the elasticity of the tracheobronchial tree, the airway ruptures, usually at the membranous portion. This mechanism has been demonstrated experimentally in a canine model [14]. The third theory relates to rapid deceleration, such as that experienced in motor vehicle accidents. The lungs are fixed at the carina, whereas they are more mobile within the pleural space. Rapid deceleration produces a shearing force, causing rupture of the trachea and bronchi [3]. This mechanism of injury seems the most logical in the current population of blunt trauma victims, the majority of whom are involved in motor vehicle accidents.

The higher incidence of right bronchial injuries may be from the shorter length of the right main bronchus compared with the left. However, the right bronchus is also less protected than the trachea or the left bronchus, which are encircled by the aorta and other mediastinal tissues. The heavier right lung on the shorter right main bronchus may also play an important role in the amount

### Table 4. Successful Outcomes for Surgical Treatment (Repair or Resection) of Blunt Tracheobronchial Injuries After Increasing Periods of Delay Until Treatment

<table>
<thead>
<tr>
<th>Days Until Treatment</th>
<th>Surgical Repair % (Ratio)</th>
<th>Resection % (Ratio)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–7</td>
<td>77 (53/69)</td>
<td>50 (5/10)</td>
</tr>
<tr>
<td>8–30</td>
<td>88 (22/25)</td>
<td>75 (3/4)</td>
</tr>
<tr>
<td>31–60</td>
<td>78 (18/23)</td>
<td>71 (5/7)</td>
</tr>
<tr>
<td>61–365</td>
<td>90 (27/30)</td>
<td>90 (9/10)</td>
</tr>
<tr>
<td>&gt; 365</td>
<td>89 (8/9)</td>
<td>78 (7/9)</td>
</tr>
</tbody>
</table>
of traction force experienced in deceleration injuries. Although some investigators have found equal frequency of right-sided and left-sided injuries [3, 6–9, 13, 15–17], others also have noticed an increased frequency of right main stem injuries [2, 6, 18]. Our report, which includes all patients reported in sufficient detail, clearly demonstrates that right-sided injuries are more common both overall and in patients diagnosed and treated within 24 hours. The acuity of the presentation of a patient with a right-sided injury may be related to a higher incidence of associated injuries. Right-sided injuries may also be detected earlier because injuries to the left bronchus are more protected by adjacent structures in the mediastinum. Likewise, the added protection of the left bronchus may account for the increased time between injury and treatment for the left-sided injuries when compared with right-sided injuries.

Regardless of the side of the injury, the mortality was higher in patients diagnosed and treated earlier in the course of their disease. Some authors have suggested that the high early mortality in blunt tracheobronchial trauma is from other associated injuries [3, 18]. For patients with blunt tracheobronchial injuries, Jones and colleagues [18] reported an average of five associated injuries in patients who died compared with three associated injuries in patients who survived. The survivors experienced less severe injuries, such as bony fractures and closed head injuries [18]. The increased early mortality we report appears to result from coexisting fatal injuries and not necessarily the tracheobronchial injury.

Tracheobronchial injuries are not diagnosed immediately in 25% to 68% of patients [8, 9, 13, 16, 17, 19–21]. Taskinen and associates [17] described a surrounding layer of peribronchial tissue, especially on the left, which may be adequate to allow continued ventilation past an area of bronchial injury. However, in 2 to 6 weeks, the bronchus can become obstructed by granulation tissue, preventing air exchange. Those bronchi that do not completely obstruct but remain stenotic tend to develop postobstructive pneumonia and bronchiectasis. This development usually leads to nonfunctional lung tissue distal to the area of stenosis, even if the airway can be restored. However, when the airway is completely obstructed, the distal lung is often filled with mucus and protected from infection. Studies by Webb and Burford [22] and Benfield and associates [23] have demonstrated in a canine model that bronchi experimentally occluded for 5 to 7 months can be repaired and reaerated with return of physiologic function. Patients with chronic but complete bronchial obstruction do not have parenchymal destruction but instead maintain functional pulmonary tissue beyond the point of obstruction.

The surgical approach to repair of these tracheobronchial injuries is dictated primarily by the location of injury. A patient with a suspected airway injury should undergo fiberoptic bronchoscopy for diagnosis and localization of the injury. Both surgical incision and intraoperative ventilation is dictated by the location of the injury and the surgical approach to the area. Surgical debridement of the area of acute injury and excision of scarred, narrowed segments of chronic tracheobronchial injuries should be performed to create healthy edges that can be repaired successfully. Often the airway distal to the chronic obstruction will be filled with mucus, which must be removed to allow adequate ventilation of the atelectatic segment. Follow-up bronchoscopy to evaluate the airway anastomosis is recommended at 1 to 2 weeks after operation.

We found reports of 46 patients who had successful repair of chronic tracheobronchial obstruction from 3 months to 34 years after injury. In fact, patients with delayed repair of their injury did as well as, if not better than, those patients who had immediate repair or delayed pulmonary resection. In most patients who underwent resection, the lung beyond the obstruction was believed to be nonfunctional; however, in several reports, the resected lung was found to be completely normal on pathologic examination and may have been able to be preserved.

Overall, patients undergoing repair of a blunt tracheobronchial injury reported an improvement in lung function. However, the improvement is subjective because little documentation exists to quantify this improvement. The patient described herein also reported improvement after repair and had documented improvement in pulmonary function tests. Of the 5 patients for whom postoperative pulmonary function tests were available, only three returned to normal values. This finding may suggest a continued restrictive process, perhaps related to the initial trauma or, in many cases, to repetitive thoracotomies and loss of intrathoracic volume. Furthermore, the data in our study were drawn from reports in the literature; therefore, they may be biased towards patients with successful outcomes.

Summary
Motor vehicle accidents with high-speed deceleration have become more prevalent since the 1950s and have caused the majority of tracheobronchial injuries experienced today. Both deceleration and crush injuries occur at or near the carina and most commonly involve the right main bronchus. Injury to the right bronchus or trachea predicts a worse outcome when compared with left-sided injuries. However, right bronchial and tracheal injuries are usually diagnosed within 24 hours of injury, and the significant early mortality rate reported here and by other investigators appears to be related to coexisting injuries rather than the tracheobronchial injury itself. Immediate diagnosis of blunt injury to the trachea and bronchus is sometimes difficult. Instead of being a dramatic acute presentation with a large air leak, tracheobronchial injuries from blunt trauma often present as an indolent process involving retained secretions, poor lung expansion, recurrent pneumothoraces, and eventually high-grade bronchial obstruction; thus the diagnosis is often delayed.

Our extensive review examined the largest collection to date of patients with tracheobronchial injuries. Although early diagnosis is becoming more common, many
patients are not diagnosed until more than 7 days after injury, even in the current era. This study supports repair of the chronically obstructed bronchi after blunt injury if the lung appears functional. Patients with blunt tracheobronchial injuries can benefit from the return of lost lung function by undergoing repair of the injury, and often they do not require the resection of pulmonary tissue that actually may be functional.

References
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