Traumatic and iatrogenic lesions of the trachea and bronchi

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Abstract

Objective: The traumatic lesions of the trachea and the main bronchi appear to be rare, but as complications of the severe chest and neck injuries they require urgent surgical treatment. Unfortunately for the last few years the incidence of such traumas has increased. Methods: During the last 15 years we have treated 28 patients (20 male and eight female) with traumatic lesions of the tracheobronchial tree aged from 8 to 64 years. The tracheal lesions were predominantly iatrogenic caused by difficult endotracheal intubation. The lesions of the bronchi (12 of the main and three of the lobar) were caused mainly by blunt traumas (car accidents and falling from heights). Total disruption of the right main bronchus was observed in five cases and of the left main bronchus – in seven cases. Emergency operative treatment was performed in all patients within 6 to 12 h after the incident. Cervical approach was performed in eight patients and posterolateral thoracotomy in the other cases. Results: We had one death in the early post, which was due to a severe trauma. Excellent and good results were obtained in 27 patients, which recovered well within 3 months and were followed up for periods ranging from 1 to 10 years. Conclusion: The traumatic lesions of the trachea and main bronchi require emergency surgical treatment. The proper choice of operative approach is largely dependent on the precise early diagnosis and on the determining of the exact location of the lesions. Operative tactics must aim at optimal preservation of the functional lung parenchyma and have to include reconstructive and plastic procedures. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Tracheal; Bronchial injuries; Chest trauma

1. Introduction

The incidence of isolated or multiple severe chest traumas in common surgical practice has been increasing during the recent years [1–5]. The cases with lesions of the trachea and the main and large bronchi seem to be one of the most serious conditions in blunt and penetrating neck and chest traumas [6–8]. The brief historical observation confirms that surgeons were acquainted with the problem more than a century ago. Nissen [23] and Sanger [9] reported the first successfully performed surgical treatment through pneumonectomy of a delayed traumatic stricture of the main bronchus [9]. Griffith reported the first successful plastic operation of bronchial laceration [10]. Recently an increasing number of autopsy studies and of successfully treated patients with airway injury including a group of cases with iatrogenic lesions were reported [11–13]. Nevertheless the tracheo-bronchial injuries still represent a difficult curative problem [14,15]. Some severe complications like empyema, fistulas, mediastinitis and strictures of the trachea and main bronchi can develop because of late diagnosis [3,7]. Here we would like to report the evaluation of our experience with diagnosing, selection of the surgical approach and the operative treatment of the tracheo-bronchial injuries. This study has been performed in order to help identify high-risk patients and to achieve an effective surgical treatment.

2. Patients and methods

At the Emergency Medicine institute ‘N.I. Pirogov’, the Military Medical Academy and in cases of emergency in other hospitals 28 patients with traumatic lesions of the tracheo-bronchial tree were operated over a period of 15 years. Out of them only eight were female and the rest 20 were male aged between 8 and 64 years (average age - 36 years).

Nine patients with iatrogenic lesions caused by the insertion of the endotracheal tube (in five patients for thoracic operation and in four patients for abdominal surgery) were treated.

In two cases the tracheal lesion was due to a blunt chest trauma and in another two, to stab wounds. The lesions of
the bronchi were due to blunt traumas in car accidents with acceleration and deceleration (six patients), crushing from heavy weight object (four patients) and falling from heights (five patients). The location, type and frequency of the tracheo-bronchial lesions are shown on Fig. 1.

Associated injuries in our cases were a common occurrence because of the great magnitude of the trauma. The incidence of associated injuries and the most common complications in the patients with tracheo-bronchial lesions due to blunt chest trauma occurred as follows on Table 1.

Requiring proper data for the type of the trauma and clinical examination were the first methods used to confirm the diagnosis. Clinical symptoms of the traumatic lesions of the trachea, main and segmental bronchi in our patients after a blunt chest trauma are shown on Table 2. Pneumothorax was observed in 22 (78.6%) of our patients while in the rest of them deep cervical and mediastinal emphysema occurred.

Chest X-rays were a routine method of examination in all patients (Fig. 2). CT Scan and EMRI were additional diagnostic methods in five patients. The performed bronchography in six of our patients confirmed the diagnosis without side effects (Fig. 3). Early radiological signs indicating traumatic lesions of the airways were: total or tension pneumothorax – 14 patients; multiple fractures of ribs – 13 patients, especially including the first three; deep cervical and chest surgical emphysema were observed in all patients in a different degree; mediastinal emphysema occurred in 12 patients. Direct evidence for bronchial ruptures was manifested with collapsed lung descending under the hilum, obstruction of the airways and a sleeve of air surrounding the bronchus.

Tracheobronchoscopy was performed on 21 of the patients. Recently this has become the routine diagnostic method in cases of major blunt chest trauma. The specific indications for bronchial endoscopy were any suspicion for airways injuries, refractory pneumothorax with ineffective thoracic drainage, traumatic haemotysis, increasing surgical emphysema, mediastinal emphysema and deep cervical emphysema. Bronchoscopy was performed in eight cases as a guide, in order to avoid the risk of blunt intubation in the damaged airways. Thoracoscopy was performed only in four patients. In three of the cases undergoing thoracic operations the tracheal rupture was diagnosed intraoperatively after intubation with Carlen's tube. The increasing mediastinal emphysema and unexpected air leak observed during the operation indicated a revision of the membranous part of the trachea. Twenty-one patients were operated in emergency from 3 to 12 h after the admission. The rest of the patients underwent surgery within 72 h because of poor general condition and late diagnosis. One patient was operated a week after the lesion because of the delay of the diagnosis in a provincial hospital.

In the cases with high tracheal lesions a cervical approach

| Table 1 |
| Incidence of associated injuries in patients with blunt chest trauma and airways lesions |

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractured ribs</td>
<td>13 (86.6%)</td>
</tr>
<tr>
<td>Pulmonary contusion</td>
<td>11 (73.3%)</td>
</tr>
<tr>
<td>ARDS</td>
<td>3 (20%)</td>
</tr>
<tr>
<td>Hemothorax</td>
<td>6 (40%)</td>
</tr>
<tr>
<td>Myocardial contusion</td>
<td>4 (26%)</td>
</tr>
<tr>
<td>Head and spinal cord trauma</td>
<td>6 (40%)</td>
</tr>
<tr>
<td>Bone fractures</td>
<td>7 (46%)</td>
</tr>
<tr>
<td>Abdominal visceral injuries</td>
<td>3 (20%)</td>
</tr>
</tbody>
</table>

| Table 2 |
| Clinical symptoms in the patients with blunt chest trauma and tracheo-bronchial lesions |

<table>
<thead>
<tr>
<th>Clinical symptoms</th>
<th>Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>100</td>
</tr>
<tr>
<td>Cough</td>
<td>100</td>
</tr>
<tr>
<td>Cyanosis</td>
<td>100</td>
</tr>
<tr>
<td>Tachycardia</td>
<td>100</td>
</tr>
<tr>
<td>Shortness of breathing (Dyspnea)</td>
<td>100</td>
</tr>
<tr>
<td>Subcutaneous surgical emphysema</td>
<td>100</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>87</td>
</tr>
<tr>
<td>Blood-spitting</td>
<td>78.6</td>
</tr>
<tr>
<td>Shock</td>
<td>39.3</td>
</tr>
<tr>
<td>Low blood pressure (80–90/60 mm/Hg)</td>
<td>73.3</td>
</tr>
</tbody>
</table>
Fig. 2. Chest X-rays of a traumatic rupture of the right main bronchus: direct evidences for a bronchial rupture – total pneumothorax with the collapsed lung descending under the hilum. Unsuccessful treatment with a chest drain.
with partial sternotomy to the third intercostal space was undertaken (eight patients). In the cases with lesions in the lower third of the trachea we used a high postero-lateral right thoracotomy. A standard dorsal thoracotomy in the 5th inter-rib space was performed for bronchial ruptures.

Major operations performed on the tracheo-bronchial tree:

1. Total reimplantation of the main or segmental bronchus – 13 patients.
2. Suture of lesion of the trachea or main bronchus – 12 patients.
3. Right upper lobectomy. - one patient.
4. End to end tracheal anastomosis with esophageal anastomosis in one stage with temporary gastrostomy – 1 patient.
5. Suture of the trachea, cervical esphagogostomy with closure of the distal end of the esophagus and gastrostomy as first stage. Colon substitution of the esophagus with isoperistaltic right colon was performed 3 months later in 1 patient.

Careful dissection of the trachea and injured main bronchi allows good approach and precise suturing. We apply two slings, above and under the lesion. On the membranous part of the trachea we place a continuous stitch with a traumatic ‘Vicril’ 3/0. During the reimplantation of the bronchi we economically incise the edges of the torn bronchus and stitch the anastomosis with interrupted sutures.

3. Results

We obtained excellent results in 23 of the treated patients. Atelectasis of the lung in the early postoperative period after plastic reimplantation of the main bronchus developed in four patients. They made good recovery after bronchoaspiration and treatment with expectorants and bronchodilators.

There were no complications due to the operation. In the early postoperative period one patient died because of the severity of the multiple traumas, developing adult respiratory distress syndrome (ARDS).

In the late postoperative period local granulation in the place of the anastomosis appeared in three patients (3.4%), which were treated successfully with bronchoscopy and laser.

The rest of the patients were followed up for periods ranging from 1 to 10 years remaining well and with good respiratory function tests.

Fig. 3. Bronchography of a traumatic rupture of the left main bronchus.
4. Discussion

Unfortunately a rapid increase of disastrous road traffic accidents and traumatic civilian fatalities have been reported recently [2,8,15–17]. In about 60–75% of them, injuries of the thorax are a major trauma factor. The injuries involving the airways are rare but have been observed with an increasing frequency for the last decade, not predominantly in autopsy studies but in cases treated in trauma centers. The iatrogenic lesions caused by endotracheal intubation continue to be the most common tracheal injuries in our practice. Although successful management of these injuries has been reported, they remain a life-threatening condition [18–20]. The successful outcome depends on the early assessment of the traumatic injuries of the chest and neck with high level of suspicion. Careful history of the nature of the trauma and a thorough examination should be sufficient for a proper diagnosis. The persistent symptoms of shortness of breath, cyanosis, pain, cough, blood-sputting and tachycardia in the cases of severe chest trauma with fractured ribs, pneumothorax, and subcutaneous surgical emphysema are significant enough to indicate lesion of the airways [6,15]. Usually the clinical manifestation depends on the location and severity of the airway trauma. Refractory pneumothorax with continuous airleak from the chest or mediastinal drains with failure of the lung expansion and an increasing dyspnea is a very important symptom for a tracheo-bronchial lesion [21].

Routine chest X-rays and bronchoscopy are sufficient for proper diagnosis in more than 90% of the cases [20].

The clinical presentation and radiological examination categorized two types of patients with airway lesions [6]. In the first group the airway opens directly into the pleural cavity. In second type the pleural integrity is preserved and the airleak is sealed off by the mediastinum. Increasing subcutaneous emphysema starting from the neck, head and slipping down on the chest is typical for the second group classes.

The level, extent, type, and length of the lesion determine the proper surgical approach. The primary plastic reconstruction includes careful dissection, economy incision of the tracheal or bronchial edges and precise mucosa-to-mucosa anastomosis. Recent surgical experience confirms that early surgical therapy gives a mortality rate of about 5%, while among conservatively treated patients it is above 50% [22]. Trauma of the magnitude required to rupture an airway almost always causes pulmonary contusion. This requires a proper evaluation of the lung tissue before the plastic procedure. The lung resection is a method of choice when the tissue damage is irreversible.

A very important factor for determining the outcome is close collaboration between anesthesiologists and surgeons as a team.

The intensive care in the early postoperative period is of great importance. To ensure good recovery a prophylactic with broad-spectrum antibiotic, effective ventilation with tracheobronchial toilet and pain relieve are essential. [3,13]

5. Conclusions

- The number of the emergency treated patients with isolated chest or multiple trauma and airways lesion has increased.
- The key for a successful outcome is a high level of suspicion for airway injuries in the cases of severe chest and neck trauma.
- The proper history of the trauma, examination, radiography and bronchoscopy give early diagnosis of the airways lesions and improve the outcome.
- The high frequency of serious associated injuries and the severity of chest trauma predict the final outcome.
- The principles of the surgical treatment are based on an early operation. The plastic reconstruction includes adequate debridement and mucosa-to-mucosa anastomosis. This is possible when the lung parenchyma is preserved. Good functional results are obtained when the injuries are limited to the major airways.

References

Appendix A. Conference discussion

Dr J.F. Velly (Pessac, France): This is a difficult challenge in the field of traumatism. I heard you had a classical but rare truly esophageal-associated lesion. How do you ventilate the patients? Do you use a single tube, a double tube or jet ventilation?

Dr Tcherveniakov: Because of the shortage of time I did not succeed in presenting in detail the methods of ventilation. In general it is very important to have a good co-operation between the surgeon and the anesthesiologist. They must work in a good team to treat this group of patients. Actually we used jet ventilation in only three of our patients. Otherwise, we perform a single lumen tube in the cases with tracheal lesions and double lumen tube in the cases with bronchial lesions. We remove the endotracheal tube placing continuous sutures of the posterior wall and insert it again to place interrupted sutures on the anterior wall.

Dr F. Vermassen (Gent, Belgium): I have some questions about the group of patients where the indication was posterior trauma of the trachea after intubation. After introduction of the percutaneous technique for tracheostomy in our ICU unit, we saw a few cases in which total disruption of the posterior wall of the trachea had occurred. All these were treated conservatively and without complications. So my question is, what are your criteria to go for an operation in these patients?

Dr Tcherveniakov: In our practice we haven’t had limited short traumatic lesions of the membranous part of the trachea or patients with percutaneous tracheostomy. We performed the operations on patients with lesions longer than 5 cm. The size of the lesion is our criteria for the operative treatment. The conservative treatment takes place in the cases with small tracheal lesions.

Dr Velly: I also agree there is a place for the conservative treatment in some selected cases.

Dr Tcherveniakov: Yes, probably.

Dr Velly: In your experience, do you see an increase in laryngotracheal disjunction, or not?

Dr Tcherveniakov: One of our patients had such a type of lesion just under the larynx from a wire cut. He was a motorcyclist who was caught by a stretched wire. We operated together with otolaryngologist and direct anastomosis was performed.