Iatrogenic ruptures of the tracheobronchial tree[☆]

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Abstract

Objective: Iatrogenic tracheobronchial ruptures are seldom but severe complications after intubation or bronchoscopy. Therefore, we evaluated the reasons, the subsequent therapy and the outcome of patients with tracheal rupture, who were admitted to our hospital. **Methods**: In a retrospective study we examined 19 patients (15 women, four men; 43–87 years) treated for acute tracheobronchial lesions. Eleven (58%) patients had a tracheobronchial rupture by single-lumen tube, four (21%) by double-lumen tube and two patients (10%) by tracheal cannula. A total of 47% of whom were carried out under emergency conditions. Two patients had a rupture due to a stiff bronchoscopy. Mean symptoms were mediastinal and subcutaneous emphysema. Two emergency collar incisions had been done. **Results**: The localization of ruptures was in all cases in the paries membranaceus, length: 1–7 cm (mean: 4.8 cm). The interval between the onset of symptoms and the diagnose differed widely (up to 72 h), nine (47%) diagnoses were made during intubation/bronchoscopy. One patient, with a small tear (1 cm) was treated conservatively with fibrin-glue. The other 18 patients had surgical repair through a thoracotomy. The postoperative mortality was determined with 42%, which was not dependent on the rupture but basically by the underlying diseases requiring intubation. **Conclusions**: Iatrogenic tracheal rupture is a dangerous complication with potentially high postoperative mortality, mostly influenced by the underlying disease. Early surgical repair must be the preferred treatment. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Tracheobronchial rupture; Iatrogenous; Surgery; Outcome

1. Introduction

Chronic lesions of the trachea with stenoses after long-term intubation are the most frequent indications for trachea resections and/or reconstructions [1–3]. On the other hand, acute injuries of the tracheobronchial system are rare and life-threatening situations. Today, these injuries are frequently caused by intubation, tracheotomies and bronchoscopies than by thorax trauma. Apart from the effects of the mechanical process of intubation by itself, iatrogenic tracheobronchial ruptures (TBR) also seem to be linked to pre-existing primary diseases of the respective patients [4,5]. In most cases, the surgical intervention is the treatment of choice, but also conservative methods may be used.

The aim of the present study was to investigate the underlying clinical reasons, predisposing factors, diagnosis, as well as the subsequent therapy and outcome of patients having been treated for a TBR.

2. Material and methods

In a retrospective study on all patients with an iatrogenic TBR assigned to our clinic (01.01.1995–31.12.2000), we established all clinical facts regarding anamnesis, aetiology, the extent of lesions, diagnostics and therapy as well as outcome.

2.1. Clinical features

A total of 19 patients (15 women, four men) were assigned to us with an iatrogenic TBR. Their mean age was 69 years (range 43–87 years). Eleven patients (58%) had been intubated by a single-lumen tube, eight (73%) are being performed under emergency conditions. Only two cases (10%) were reported as 'difficult intubations'. Four patients (21%) were provided with a double-lumen tube electively in preparation for thoracic surgery. In two patients (10%), the iatrogenic TBR was caused by tracheal cannula, which was placed under emergency conditions in one case during a percutaneous dilational tracheostomy.

Table 1
Comorbidities of patients with TBR

Concomitant disease	n
Severe cardiac or pulmonary disease	
– Coronary disease/myocardial infarction	3 (16%)
– COPD, pneumonia	6 (32%)
Tumor	
– thoracal	6 (32%)
– extrathoracal	2 (11%)
Inflammatory disease	3 (16%)
Other diseases	3 (16%)

Moreover, two patients (10%) suffered from a TBR due to a stiff bronchoscopy. Five of the nine emergency intubations were performed outside the hospital by an emergency medical services and four inside the hospital in resuscitation situations by non-anaesthesiologists.

All patients had substantial primary illnesses which made the intubation more difficult, or they had non-negligible comorbidities (Table 1). Severe cardiac or pulmonary diseases were detected in nine (47%) patients. Tumor diseases ($n = 8$) played an important role under the concomitant diseases, especially ($n = 7$) in the electively intubated patient group.

Nine TBR (47%) were diagnosed immediately after the intubation. For the whole group of patients, the mean interval between injury and diagnosis was determined with 5.42 ± 7.3 h (up to 72 h). In these ten patients, whose rupture had not been recognized immediately, mediastinal or subcutaneous emphysema (Fig. 1) led to the diagnosis in 80% ($n = 8$) of the cases, whereas a hemoptoe initiated the decision in 20% ($n = 2$). Only one patient had a pneumothorax at the same time.

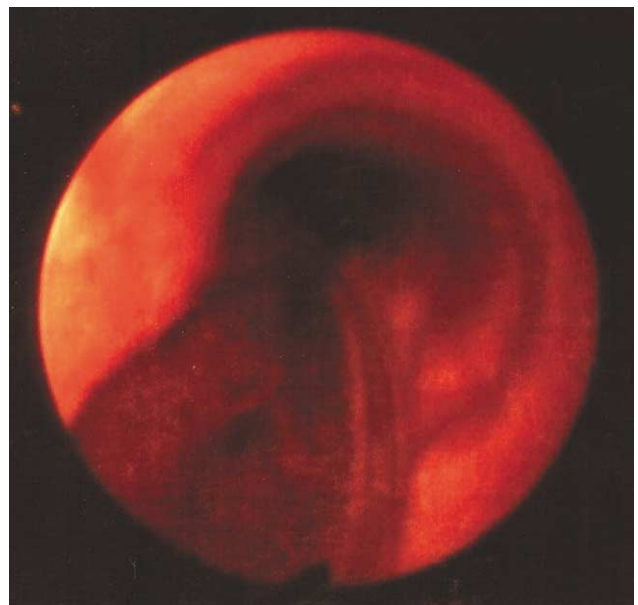Bronchoscopy (Fig. 2) verified the diagnosis nearly in all
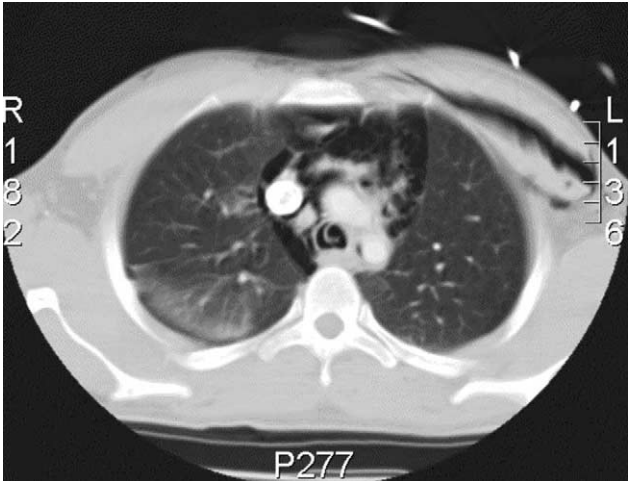

Fig. 2. Computerized tomography (CT) scan of pneumo-mediastinum.

cases (18/19). In one case, the cuff tube was localized outside the trachea after an oesophagus resection.

The mean length of the lesions was determined with 4.8 ± 1.8 cm (range of 1–7 cm). A total of 58% ($n = 11$) of injuries were located in the lower third and 10% ($n = 2$) were found in the middle third. The upper third of the trachea had not been affected in any cases. Four (21%) of the ruptures crossed the centre and the lower part of the trachea. Due to a double-lumen intubations, only two patients suffered from injuries in the left main bronchus. All ruptures were found in the area of the paries membranaceus.

3. Results

A total of 18 patients (95%) underwent a surgical treatment of their ruptures. Only two of these patients had to be subjected to a previous emergency collar incision due to massive mediastinal emphysema. The surgical intervention was performed through a right thoracotomy in 17 patients. One patient had a left thoracotomy with an isolated injury of the left main bronchus including the left lower lobe

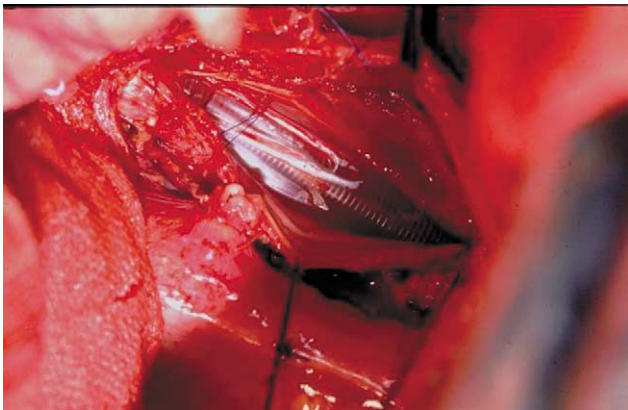Fig. 1. TBR in the paries membranaceus (bronchoscopic view).

Fig. 3. TBR in the distal trachea. Endotracheal tube is visible in the tracheal lumen.

Table 2
Analysis of possible risk factors with outcome

	Death group ($n = 8$)	Survive group ($n = 11$)	P-value
Gender (m:f)	0:8	4:7	0.1
Age (years)	70.7 ± 1	67.7 ± 11	0.59
Time intubation-symptoms (h)	0.5	1	0.36
Extend of lesion (cm)	4.3 ± 1.2	4.9 ± 2.1	0.53
Emergency intubation	4	5	0.9
Severe cardiac or pulmonary diseases	5	4	0.37
Tumor disease	4	4	0.65

bronchus, which was caused by a double-lumen intubation. The paries membranaceus was adapted by absorbable interrupted sutures in all cases (Fig. 3). Only one patient underwent conservative treatment basically by a small trachea lesion of 1 cm.

Out of the 18 patients subjected to surgical treatment, none could be extubated immediately after the operation. In only five cases (29%), a successful weaning was possible within 24 h after the operation.

One patient died during the operation from a cardiovascular failure, and seven patients (37%) died between the 10th and 36th post-operative day, in most cases from multiple organ failure. Three patients were autopsied and massive cerebral haemorrhage, septicopyemia and a septic/toxic shock process were determined as causes of their death. Only in one case a dehiscence of the surgically treated TBR was diagnosed. As shown in Table 2, we could not determine any correlation between important risk factors (e.g. demographic data) and postoperative mortality.

Eleven injuries healed per primam and the patients had a satisfactory bronchoscopy 8–14 days after repair. In the follow-up of these patients, distant bronchoscopic control revealed no evidence of tracheal stenosis.

4. Discussion

Acute lesions of the tracheobronchial tree are very rare and are caused rather iatrogenically than by trauma [6]. Many anatomical and mechanical factors may be responsible for inducing a TBR [7]. Women (Table 3) are more frequently affected by an iatrogenic TBR. Certainly, their small body size (50% of the women were ≤160 cm tall) and therefore the risk of placing the tube too much downwards in a short trachea and/or an inadequate tube size might be responsible [8]. Additionally, a vulnerable and weak trachea is often suspected in woman [7,9]. Inadequate intubation tube size is one of the most important risk factors [8]. Furthermore, the circumstances of intubation play an additional role, [7,8] since the proportion of emergency intubations with stress situations (Table 3) is very high [7,8].

The clinical symptoms (mediastinal/subcutaneous emphysema, haemorrhage) mostly appear very fast during the artificial respiration, so that a large number of injuries is diagnosed shortly after intubation (47% in the present study). The symptom of pneumothorax varies widely (from 0 to over 60%) [6,10]. Pneumothoarx occurs only if the TBR communicates freely with the pleural space (our study: 1/19). Nevertheless, long intervals without any detectable symptoms have been observed, too (Table 3).

A fiberoptic bronchoscopy and a conventional radiography of the thorax are the preferable tools of diagnosis. Tracheobronchoscopy can sufficiently determine the extension and depth of the lesion, thus allowing to plan the best treatment. In contrast, computerized tomography (CT) is only necessary in some cases of suspicion in non-detectable mediastinal bleeding or mediastinal emphysema, which are not visible by conventional chest X-ray, while oesophagoscopy is very seldom and only indicated if a tracheooesophageal connection is suspected.

In patients with small tears, stable conditions and a minimal and asymptomatic pneumomediastinum and/or cutaneous emphysema, the TBR can be treated conservatively. Based on some own bad experiences with conservative treatment of TBR [11], we treated only one patient conservatively in our series and believe that only small and superficial tears may spontaneously heal without risk of early (e.g. infection) or late complications (e.g. stenosis). In the literature, the borderline for a conservative treatment extends from 2 to 4 cm [12]. Therefore, our strategy is an operative repair for TBR larger than 2 cm.

In this regard, a surgical treatment of TBR is also considered as the preferred therapy by many other authors [6,8,9,13,14], because this relatively simple intervention

Table 3
Review of TBR in the Literature

	n	Gender		Intubation		Condition of Intubation		Diagnosis (h)		Treatment		Mortality (%)
		Male	Female	DL	SL	Normal	Emergency	Median	Mean/SD	Medical	Surgery	
Marty-Ané 1995	6	0	6	–	6	3	3	4	4.7 ± 4.8	1	5	33
Massard 1996	14	1	13	1	9/4	7	7	24	32.71 ± 36.88	1	13	14
Kaloud 1997	12	2	10	4	8	9	3	15	18.83 ± 20.72	0	12	25
Borasio 1997 [17]	10	1	9	2	8	10	–	0	6 ± 27.63	3	7	0
Mussi 2000	11	1	10	4	7	10	1			2	9	0
Own results	19	4	15	4	11/2/2	10	9	1	5.42 ± 15.85	1	18	42

will be followed by primary healing. Patients suffering from an acute respiratory distress [12] and who were operated on lungs or mediastinum should be treated surgically by any means [13] and patients with indication for tracheostomy as well [12].

In general, the TBR of the middle and lower third were operated on by a right and in rare exceptional cases by a left thoracotomy [10]. The approach for injuries in the upper third of the trachea is the left cervical side [15]. Angelillo-Mackinlay proposes a transcervical access in the sense of a mediastinotomy for injuries to the distal trachea [16], which is, nevertheless, fairly controversial, due to the creation of an additional trauma (longitudinal tracheotomy). For the repair, patients should be intubated using a double-lumen tube. Single lumen tube with position in the contralateral main bronchus or high-frequency jet ventilation can be used alternatively. However, disadvantages of the jet ventilation technique are the tendency to produce carbon dioxide retention and the danger of blood aspiration into the bronchial system. After limited lateral and posterior paratracheal dissection, the injury is repaired by interrupted or running absorbable suture, sometimes covered with mediastinal fat or pleural flap and/or by fibrin glue.

To avoid any new complications caused by the tube or elevated pressure of the artificial ventilation, an early extubation with spontaneous respiration must be the aim in all patients. But a non-necessity of mechanical ventilation after the operation is rare [6]. Only 29% of patients were extubated in our study within the first 24 h, because the postoperative course was mainly determined by the concomitant disease. Especially in case of emergency intubations, the primary disease has often not been treated directly, so that the further prognosis of patients is determined by the concomitant diseases [6].

The total mortality of 42% in our study is relatively high compared with other studies (Table 3). Since, we could not show any risk factors for postoperative mortality (Table 2), it must be discussed if our indication for surgical treatment is to hard and if some patients might have had a better outcome with a conservative treatment. Nevertheless, 53% of our patients had an emergency intubation (exclusively stiff bronchoscopy), which is clearly above the average of 31% for emergency intubations compared with the literature [13]. Studies with a high emergency intubation rate are generally accompanied by a higher mortality rate (Table 3).

Moreover, the mean length of the lesions was with 4.8 cm larger than the described borderline of 2 cm [10] in 17 of 18 patients and larger than 4 cm [12] in 11 patients, respectively. Certainly, it should be discussed the maximal length of lesions for distinguish between a conservative or a surgical treatment, but there was no alternative for surgical repair in almost all cases of our study.

In conclusion, iatrogenic TBR are mainly caused by emergency intubations. Percutaneous dilational tracheostomies and double-lumen intubations do not show higher signs of complications compared with single-lumen intubations or conventional tracheotomies, if they are accompanied by verification through bronchoscopy. Patients without any respiratory failure and a small TBR may undergo conservative treatment. They must be checked by repeated bronchoscopies to detect granulation tissue and relevant tracheal stenosis. Early surgical treatment must be the therapy of choice. It offers good local results, whereas the patients' prognosis is mostly determined by the concomitant disease and not by the injury per se.

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