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Iatrogenic tracheobronchial ruptures – treatment and outcomes

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Abstract

In the present paper we discuss the indication and follow-up of 42 patients with iatrogenic tracheobrochial ruptures. Thirty-five patients were treated by operation and 7 patients were treated conservatively. In the operated patients, four developed an insufficiency of the tracheal closure and the rupture related mortality was 2.8%. A significant effect on suture dehiscence was seen for mediastinitis ($P<0.005$) prior to operation, prior resection of the esophagus ($P<0.001$), and a long delay between injury and diagnosis ($P=0.004$). In the conservatively treated group the rupture related mortality was 29%. In conclusion to our results we suggest a surgical procedure whenever a tracheobronchial rupture is diagnosed and the patient's constitution allows the surgical procedure or anesthesia.

Keywords: Trachea; Bronchus; Rupture; Suture; Outcomes

1. Introduction

Iatrogenic tracheobronchial rupture (TBR) is a rare emergency [1–4]. Recommendations for treatment are based on retrospective analyses of small groups of patients, reviews of the literature, and case reports. The indication for surgical or conservative treatment continues to be a subject of controversy.

In the literature, one of the most important reasons for iatrogenic tracheobrochial ruptures is percutaneous dilatational tracheotomy which is often used on the intensive care unit for long-time respiratory management [2]. Other reasons are brochoscopy with or without stent implantation, emergency intubations or intubations with double-lumen tube [3,4]. Beside subcutaneous emphysema, there is a lack of an early typical clinical sign, so that the bacterial colonization of the mediastinum and the systemic infection response is the first indication to a potential airway leakage [5].

The recommendations for the conservative treatment are small lesions of the trachea without any clinical or radiological signs of involvement of the mediastinum. But this way of treatment needs close follow-up with brochoscopy and CT-scan [4,5]. If it is possible to place the cuff of the tube below the lesion, or spontaneous breathing is unaccompanied by respiratory distress and no signs of general infections occurred, conservative treatment is also justified [6,7]. In the case of conservative treatment a suspected injury of the esophageal tube always needs to be ruled out by endoscopy [8]. Another reason for the recommendation of a conservative treatment is an unacceptable high anesthetic or surgical risk [9].

Based on the literature, surgery is advised by complete rupture of the tracheal wall, problems in ventilation or a surgical drainage of the mediastinum is necessary [10,11]. In general, it has to be taken into account that the published mortality rate in conservatively treated patients is higher and as soon as clinical deterioration has taken place the conditions for surgical repair are also more difficult [11–13]. The aim of the present study is to evaluate the outcome of surgical repair or conservative treatment of iatrogenic tracheobronchial rupture and determine risk conditions to develop a therapy regime.

2. Patients and methods

Our retrospective analysis included all patients with an endoscopically identified tracheobronchial rupture treated in the surgical centers of the Universities of Leipzig and Halle within the period between 1 January 1995 and 31 July 2004. Only patients with iatrogenic tracheobronchial rupture were included.

The data collection included the case history, diagnostic work-up, treatment, and outcome. All patients were subjected to a tracheobronchoscopic and computed tomographic investigation prior to treatment, and underwent a follow-up tracheobroncoscopy between the 10th and 14th

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postoperative day. In the conservative group the clinical management consisted of antibiotic therapy, thoracic drainage and close brochoscopic controls. In all surgical cases ($n=35$) access was through a right lateral thoracotomy in the fourth intercostal space. In 12 patients (29%), the suture was additionally covered with the patient's own tissue – using pleura in three cases, and in one case esophagus and in another one esophagus and pleura as covering material. In the remaining seven cases fibrin glue-coated collagen fleece was applied locally in four cases, and an antibiotic-impregnated collagen fleece in three cases.

2.1. Statistic

The data collected were processed with the aid of the SPSS 11.0 program. For statistical analysis of possible risk factors for suture insufficiency and patient mortality, a four-field-table comparison of two relative frequencies, and Fisher's exact test were employed, with two-sided *P*-values <0.01 being considered significant. An exact binary logistic regression analysis was additionally applied.

3. Results

In the period under observation, we treated 42 patients with a mean age of 63 (range: 19–88) years, and mainly of female sex ($n=34$; 81%). In 81% ($n=32$), subcutaneous emphysema was the first symptom to be noted. In 5% ($n=2$) patients, hemoptysis was the first symptom. Six (14%) patients had none of the major symptoms (subcutaneous emphysema, pneumothorax or hemoptysis). The mean interval between the event leading to TBR and the establishment of the diagnosis was 22.6 h (range: 0–336 h). Concomitant diseases and causes of TBR are shown in Tables 1 and 2. There was no statistical difference between the operated patients and the conservatively treated patients.

3.1. Location and treatment of TBR

Most of the TBRs (71%, $n=30$) were located in the upper trachea with no involvement of the carina. Details of the location and incidence of the lesions are shown in Table 3 [13]. Thirty-five (83%) of the patients with a tracheobronchial rupture were operated on, and 7 (17%) were treated conservatively. The mean length of the rupture was 41 mm (range: 10–120) in the overall group, 20 mm (range: 10–50) in the patients treated by conservative means, and 45 mm (range: 15–120) in the surgically treated patients. Mediastinitis was observed in 7 (17%) patients, 2 in the conservative group and 5 in the surgically treated group. The two conservatively treated patients suffered from severe systemic inflammation, so that surgery was not possible. The diagnosis of mediastinitis was based on the clinical presentation (fever, chill), CT scan (edema, gas formation), and surgical findings (pus, necrosis).

3.2. Outcome

Twenty-six patients (62%) were discharged from hospital with unremarkable findings at the site of the TBR. In the operated group the overall rupture-associated mortality was thus 2.8% ($n=1$) and in the conservative treated patients it was 29% ($n=2$). The operated patient had a persistent suture dehiscence with severe sepsis and the two conservatively treated patients had also a severe sepsis. The overall mortality rate was 38% ($n=16$, Table 4). The causes of death are listed in Table 5.

Out of 35 patients, 4 (11%) experienced a suture insufficiency following the first repair. The mean length of the postoperative suture insufficiencies was 17.4 mm (range: 15–30 mm). At the time of the first repair all four patients

Table 1
Comorbidities in patients with TBR

Concomitant disease	*n*	% of 42
Cardiac disease	16	(38)
Pulmonary disease (COPD, pneumonia)	15	(36)
Malignant tumor	14	(33)
Thoracic	9	(21)
Extrathoracic	5	(12)
Other diseases	25	(60)

Table 2
Causes of TBR

Cause of TBR	*n*	% of 42
Percutaneous dilational tracheostomy	11	26
Emergency intubation	11	26
Intubation with a double-lumen tube	4	10
Long-term intubation	4	10
Routine intubation	3	7
Rigid bronchoscopy	2	5
Tracheal stent explantation	1	2
Radiotherapy and resection of esophagus	5	12
Spontaneous	1	2

Table 3
Types and localization of TBR [13]

Type	Localization	*n*	%
I	Upper trachea, no involvement of carina	30	71
II	Trachea with involvement of carina or main bronchus	12	29

Table 4
Mortality

Mortality	*n*	%
Mortality overall	16 of 42	(38)
TBR related mortality in conservatively treated patients	2 of 7	(29)
TBR related mortality in surgical patients	1 of 35	(2.8)

Table 5
Causes of death in patients with TBR

Causes of death	*n*
Conservatively treated patients ($n=3$ of 7)	
Thrombosis of the basilar artery	1
Sepsis	2
Surgical treated patients ($n=13$ of 35)	
Suture insufficiency and sepsis	1
Sepsis without suture insufficiency	7
Thrombosis of the basilar artery	3
Subarachnoidal hemorrhage	2

had mediastinitis and a type I lesion (trachea, no involvement of the carina). Two of the four patients with dehiscence had received prior irradiation of the mediastinal region to treat a carcinoma. All four patients underwent a second TBR repair procedure, with one requiring a third repair during which a repeat 5 mm suture insufficiency was bridged with the aid of a covered stent. The rupture then healed, and the patient was discharged.

3.3. Prognostic factors

Univariate analysis for possible risk factors revealed a significant impact on postoperative insufficiency of the tracheobronchial suture for the following parameters:

- Presence of mediastinitis ($n=4/35$ vs. $n=2/35$, $P=0.005$)
- Prior surgery in the mediastinum ($n=3/35$, vs. $n=2/35$, $P<0.001$), and
- Mean time interval between injury and diagnosis (114 h vs. 12 h, $P=0.004$).

4. Discussion

In common with other authors [14] we have also observed subcutaneous emphysema in the large majority of patients with tracheobronchial lesions. This indicates that subcutaneous and mediastinal emphysema is a key symptom and must be considered as an indication for early tracheobronchoscopy [4,7,15]. The reported basis for recommending a CT scan varies [7]. We consider computed tomography to be indicated for every endoscopic lesion that was not diagnosed immediately after its occurrence. Based on our findings, it is necessary to determine the depth of the tracheobronchial mural lesion, and to obtain treatment-relevant information on the mediastinal situation.

We submitted 83–85% of our tracheobronchial ruptures to surgical repair, a figure comparable with that reported by other centers [9].

We identified a significant association between delayed establishment of the diagnosis and the occurrence of a suture insufficiency. Only a few authors [7,9] confirm an association between delayed diagnosis and patient outcome. In this connection, we would note that in the five cases of TBR following resection of the esophagus, symptoms of TBR first appeared after a significantly longer interval of several days, and that these complex cases with extensive surgery in the mediastinum, were associated with a particularly poor prognosis. Our analysis also clearly showed that mediastinitis is a significant risk factor for suture insufficiency.

In all of our patients, surgical access was via a lateral thoracotomy. This approach has the advantage of enabling wide opening of the mediastinal pleura with relief of the emphysema, debridement and lavage in the case of mediastinitis. This approach has found general acceptance as a standard access [4]. Our own experience, however, showed that high tracheal lesions are technically difficult to deal with via this approach. Transcervical approaches and sternotomy have the disadvantage that repair of the posterior wall defect requires mobilization of the entire trachea, which necessitates transection of the lateral vascular supply and the need to look out for the recurrent laryngeal nerve in the inflamed region [4]. These two disadvantages are avoided by the transcervical-transtracheal approach, making it very interesting for the treatment of fresh tracheal injuries [4]. Using this approach, large patient cohorts have been managed since the 1990s, with excellent results [6]. By combining this approach with minimally invasive surgery it may in future prove possible to deal with lesions extending deeper into the main bronchus [6,7].

Data on suture insufficiency in the literature are few and far between. The problematic cases described were merely those with previously irradiated and operated esophageal carcinoma with a leaking esophagogastrostomy and cases with mediastinitis. In common with other authors, we consider it important to employ covering material, such as, for example, pericardium, pleura, esophagus, and intercostal, and serratus anterior muscle flaps in the case of ruptures that prove difficult to treat [4]. Our own experience shows that postoperative ventilation is also of considerable importance for the healing of TBR. Our respiratory management includes tube cuff position below the suture, ventilation pressure should be low and weaning should happen as early as possible.

In one patient who underwent two surgical revisions, we successfully employed a covered stent to treat a recurrent partial suture insufficiency. In light of the problems involved, in particular resulting from hypergranulation and the need for interventions, together with tracheal rupture following stent removal – which occurred in our patient cohort – there is a general consensus that this method should be considered only as a last resort [1]. Our stenosis rate was within the range of published figures (9%) [1].

In conclusion to our data the treatment of choice in tracheobrochial ruptures should be the early surgical repair whenever possible. Only in patients with a very high risk for anesthesia or surgical repair the conservative treatment with antibiotics and mediastinal drainage should be taken into account. The surgeon must be aware of the increased risk of suture insufficiency associated with the presence of manifest mediastinitis, prior surgery to the mediastinum and the time interval between injury and diagnosis.

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