State-of-the-art - Thoracic non-oncologic
Incidence and treatment modalities of tracheobronchial injuries in Germany

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Summary
This study presents the first systematic data collection on incidence and therapeutic management of both iatrogenic and non-iatrogenic tracheal lacerations in Germany. In this survey (n = 231 questionnaires) based on the geographical coverage of the country, the representation of all levels of service, and the inclusion of specialized thoracic departments as well as non-specialized surgical departments, a representative conspectus on the management of tracheal injuries in Germany was developed. A total number of 1033 tracheal injuries were reported; n = 429 of non-iatrogenic origin (blunt trauma: n = 276, penetrating wounds: n = 94, bullet wounds: n = 16, other etiology: n = 43) and n = 604 of iatrogenic origin (endotracheal intubations/mechanical ventilation: n = 372, dilative tracheotomy: n = 181, endoscopic interventions: n = 51). In institutions of high level of service there was a trend towards higher rates of surgical repair as opposed to conservative management. On the basis of these data the estimated risk of tracheal lacerations, due to single lumen intubation was 0.000013% and the risk of clinically significant tracheal lacerations due to dilative tracheostomy 1:575 (0.002%) and lacerations requiring surgical treatment 1:975 (0.001%). Data of this survey state that specialized thoracic surgeons to a high proportion are involved in the management of both iatrogenic and non-iatrogenic tracheal injuries.

Keywords: Tracheal injury; Tracheal surgery; Incidence; Iatrogenic tracheal injury

1. Introduction

Tracheal and tracheobronchial injuries due to trauma or iatrogenic etiology are rare but serious events, the absolute incidence is difficult to estimate [1, 2]. The National Safety Council reported a 25% rate of blunt trauma deaths due to thoracic trauma in the United States [3]. However, a rate of up to 80% of patients with blunt traumatic injury to the trachea or bronchus die before arriving at the hospital and therefore go unreported [4, 5]. Postmortem findings in patients that died after blunt trauma in Denmark noted an incidence of tracheobronchial injuries in 2.8% [6]. A review on the world literature on blunt intrathoracic tracheobronchial injuries identified a total of 265 patients [3]. No reasonable data are available on the global incidence of iatrogenic injuries, moreover, superficial lacerations without severe clinical symptoms, showing a ‘spontaneous healing’ will not be discovered at all. Available figures on the incidence of tracheal lacerations subsequent to orotracheal intubations are based on single institution experiences with an estimated range of 0.05–0.19% for double lumen intubations; the numbers for single lumen intubation are expected to be much lower [1, 2]. Posterior wall injuries occurring during dilative tracheotomies are reported within a range of 0.2% up to 0.7% depending on the operative technique [7–9]. The objective of the study was to conduct a poll on the incidence and origin of iatrogenic and non-iatrogenic tracheobronchial injuries and the therapeutic principles chosen in Germany.

2. Material and methods

This survey is based on questionnaires sent by fax to Departments of Surgery throughout Germany between February 2007 and September 2007. Attendees were selected from a complete list of active surgeons in private practice and hospitals of the Professional Association of Surgeons in Germany (Berufsverband der Deutschen Chirurgen, BDC); each region of the country was represented in proportion to its population and all major medical centers were included. As to service level, German state laws provide four types of hospitals; Level I: basic service hospitals – usually up to 200 beds and 2–3 medical disciplines; Level II: regular service hospitals – up to 300 beds, 4–5 disciplines; Level III: central service hospitals – usually up to 500 beds with a wide spectrum of up to eight different disciplines; Level IV: maximum care hospitals – big institutions, usually more than 1000 beds, mostly university hospitals with comprehensive spectrum, responsible for...
research and training as well as hospital treatment. A total of 323 questionnaires were forwarded. The questionnaire referred to both non-iatrogenic and iatrogenic tracheal injuries: in non-iatrogenic injuries the number of blunt and penetrating trauma seen in a specific time period was enquired as well as surgical or non-surgical therapeutic procedures of each group. For iatrogenic injuries (endotracheal intubations and mechanical ventilation, dilative tracheotomy, endobronchial endoscopic intervention), the questions related to the incidence observed and the therapeutic principles – surgical or non-surgical. Additionally, information was to be given on the level of service in line with the German health care system and on the specialization of the responding institution (specialized thoracic surgery, general surgery, accident and emergency, pediatric surgery, cardiothoracic and thoracic surgery). For evaluation purposes, two groups were defined: the specialist and the non-specialist group; the specialist group entailed specialized thoracic surgical institutions and departments of both cardiac and thoracic surgery, whilst the non-specialist group consisted of departments of general surgery, trauma and emergency as well as pediatric surgery. For evaluation purposes of the level of service of the responding institutions two groups were defined: high-level service (hospitals of maximum service and university hospitals) and basic service (hospitals of basic, regular and central service).

3. Results

A total number of 231 questionnaires were answered and returned (72%). A synopsis of the level of service as well as the surgical specialism of the responding departments is shown in Table 1. The observation period was five years (2001–2005) in a number of 182 responding institutions (88.3%); the medium observation time was 56.5 months (4.7 years). A total number of 1033 tracheal injuries were reported of which a total of 429 were of non-iatrogenic origin and a total of 604 were of iatrogenic origin, respectively. Blunt trauma was the predominant etiology of non-iatrogenic injuries (n=276 of n=429; 64.3%). Throughout the country within the observed period, an additional number of 94 penetrating wounds, leading to tracheal injuries, and 16 bullet wounds causing tracheal injuries, were diagnosed and treated. 65% (n=179) of blunt trauma injuries were managed conservatively; only 35% were operated on, whereas the vast majority of penetrating wounds (82%, n=77) and all (100%, n=16) bullet wounds were repaired surgically. A synopsis on the treatment modalities of non-iatrogenic injuries in hospitals of highest level of service vs. hospitals delivering basic service is shown in Fig. 1. A comparison of the treatment decisions on non-iatrogenic injuries between specialized and non-specialized surgical departments is presented in Fig. 2.

The predominant etiology of iatrogenic tracheal injuries was endotracheal intubations/mechanical ventilation (n=372 of n=604; 61.4%). A total of 181 tracheal injuries were reported occurring during dilative tracheotomy, and n=51 occurring during endoscopic interventions. Overall, 44% (n=163) of intubation/ventilation-caused injuries, and 38% (n=69) of dilative tracheostomy-caused injuries were managed conservatively, however, the rates of surgical repair for both etiologies were higher in institutions of Maximum Service and University Hospitals (intubation/ventilation: 67%, dilative tracheostomy: 78%). Furthermore, in the non-specialized thoracic departments the rate of surgical repair for intubation/ventilation-caused injuries was increased (non-specialized: 67%, specialized, 51%); the rates of surgical repair for dilative tracheostomy-caused injuries were likewise (non-specialized: 60%, specialized: 64%). A synopsis on the treatment modalities of iatrogenic injuries in hospitals of highest level of service vs. hospitals delivering basic service is shown in Fig. 3. A comparison of the treatment decisions on iatrogenic injuries between specialized and non-specialized surgical departments is presented in Fig. 4.

A total of ten surgical departments have to deal with an average of more than five tracheal injuries per year (specialized thoracic surgery: n=6; cardiothoracic surgery: n=2; general surgery: n=2). In a total of 91 surgical departments there was no tracheal injury to be managed per year. The appearance of up to one event per year was reported from 93 departments. A synopsis on the medium incidence of tracheal injuries in the specialized and non-specialized institutions is shown in Table 2.

4. Discussion

In this study, we present the first systematic data collection on incidence and therapeutic management of both iatrogenic and non-iatrogenic tracheal lacerations in Germany. Information was gathered from a total of 231 surgical departments throughout the country (quota of response: 72%). In the survey, we were able to accomplish a representative conspectus on the numbers observed and the chosen therapeutic principles of tracheal injuries in Germany, based on the geographical coverage of the coun-

<table>
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<th>Specialization</th>
<th>Level of service</th>
<th>Maximum care, University hospital</th>
<th>Total</th>
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<tr>
<td>Total</td>
<td>168</td>
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try, the representation of all levels of service, and the inclusion of specialized thoracic departments as well as non-specialized surgical departments. The first to deal with patients with tracheal injuries are frequently departments of general surgery or trauma surgery; if respiration is initially not impaired and the injury is detected with delay in presentation, thoracic surgeons often are consulted later on. Blunt trauma represented the highest proportion in non-iatrogenic tracheal lacerations \((n=276)\), with penetrating wounds \((n=94\) over five years) and bullet wounds \((n=16\) over five years) being an absolute rarity in Germany. However, the total number of blunt injuries causing tracheo-
Fig. 3. Iatrogenic tracheal injuries: incidence and treatment modalities in hospitals of highest level of service i.e. Maximum Service and University Hospital (A); and hospitals delivering basic service i.e. hospitals of basic-, regular- and central-service (B) according to the German Health Care System.

Fig. 4. Iatrogenic tracheal injuries: incidence and treatment modalities in specialized thoracic departments (S) and non-specialized surgical departments (NS).

Incidental lacerations may probably be higher, due to the high mortality of these patients before reaching a hospital [4]. Indeed it is well known, that the incidence of thoracic trauma declined after the introduction of safety belts and airbags [10]. The rate of 65% of non-surgical treatment for blunt trauma-injuries is well suited to the etiology as well as a rate of 82% of surgical repair in perforating trauma, and an up to 100% surgical repair rate for bullet wounds. A
total of 53% of patients with non-iatrogenic tracheal injuries received treatment by non-specialized thoracic surgeons and an equal rate of patients with perforating trauma (53%). In iatrogenic injuries a total of 62% of patients received treatment by specialized thoracic surgeons. This was somewhat surprising to us in the light of only 38 (16%) specialized thoracic departments of the 231 reporting institutions. Apparently, patients suffering iatrogenic tracheal injuries often are transferred towards specialized thoracic departments for definitive treatment.

In iatrogenic tracheal injuries, endotracheal intubation (with mechanical ventilation) and dilative tracheostomy were by far the most frequent etiologies (92%). Both interventions usually result in the same type of tracheal injury, a longitudinally running scar in the posterior wall. Concurrent with our own experience, and as reported in the literature in recent years, there is a strong trend towards non-operative management, especially in this type of injury [11–15]. The data obtained from this survey however, do not correspond to this recommendation; 56% of patients with iatrogenic injuries attended surgical treatment. Especially institutions of highest level of service and non-specialized surgical departments had a higher proportion of surgically-managed iatrogenic tracheal injuries. Interpretation of these data, however, is difficult because it is common practice to transfer those patients with more severe injuries for definitive treatment from smaller institutions into larger medical centers with specialized thoracic or general surgery services. On the other hand, patients with limited tracheal injuries and feasible non-surgical management often remain in the (basic-service) hospitals, which they were initially referred to.

In this study we did not ask for morbidity and mortality of the different treatment modalities. The data from institutions with a frequency of up to one event per year (n=91) are difficult to compare. A comparison of the outcome in high-volume institutions with defined concepts and criteria for surgical and non-surgical treatment of tracheobronchial injuries may answer these questions more properly.

Based on the data of our survey, a total annual number of 79 iatrogenic tracheal injuries due to endotracheal intubation and 39 iatrogenic tracheal injuries due to dilative tracheostomy are being observed in the country. In the literature, a range of 0.05%–0.19% tracheal injuries is reported for double lumen intubations – numbers for single lumen intubations are expected to be much lower [1, 2]. The total number of single lumen intubations performed in Germany per year, however, is unknown; the data of the German DRG-statistics show a total number of in-patient operations in 2006 of 12.6 millions; of that at least six million can be assumed for single lumen intubations (Federal statistical office, Wiesbaden. DRG – statistics. In patient diagnoses and procedures in German hospitals in 2006). Emergency intubations and intubations due to outpatient surgery must be added to this number. On the basis of this survey and based on these data, a very cautious assessment on the risk of tracheal lacerations, due to single lumen intubation can be estimated with an incidence of approximately 1:75,000 (0.000013%). A more reliable appraisal is possible for posterior wall lacerations subsequent to dilative tracheostomy as the annual number of dilative tracheostomies in Germany is well known; n=22.449 in 2006 (Federal Statistical Office, Wiesbaden. DRG – statistics. In patient diagnoses and procedures in German hospitals in 2006). Subsequently, the risk of clinically significant tracheal lacerations due to dilative tracheostomy can be assessed with 1:575 (0.002%); lacerations requiring surgical treatment can be assessed with 1:975 (0.001%). In the literature to date, absolute numbers on the risk of tracheal lacerations following dilative tracheostomy are not available; only single institution reports exist with a range of 0.2% up to 0.7% – depending on the operative technique used [5, 7]. The average number of tracheal injuries surgical institutions have to deal with is known to be very low. In Germany it appears that a number of ten institutions deal with more than five events per year. Data of this survey state that specialized thoracic surgeons to a high proportion are involved in the management of both iatrogenic and non-iatrogenic tracheal injuries. However, general and trauma surgeons throughout the country should be familiar with the basic principles of treatment of this rare injury, especially the chances and limitations of conservative management.

References


Table 2

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<thead>
<tr>
<th>Specialization</th>
<th>Medium Incidence per year</th>
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<td>General surgery (with emergency)</td>
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<td>Specialized trauma and emergency</td>
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<td>Specialized thoracic surgery</td>
<td>0</td>
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<tr>
<td>Total</td>
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eComment: Under representation of Germany’s specialized thoracic surgery units in maximum service hospitals impacts treatment

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In their recent national survey ‘Incidence and treatment modalities of tracheobronchial injuries in Germany’ Schneider and colleagues analyzed the frequency of iatrogenic and non-iatrogenic tracheal injuries and the characteristics of surgical units (specialized thoracic surgery units vs. others and maximum service and university hospitals vs. others) involved in the treatment of this rare traumatic entity in Germany [1]. Despite evidence-based recommendations towards more conservative treatment approaches, especially for iatrogenic tracheal injuries, the authors identified a high proportion of surgically managed injuries in both groups in institutions of highest level of service [2]. The authors, therefore, rightly conclude that surgeons being involved in the treatment of these patients should be familiar with the limitations and chances of conservative tracheal injury management.

Interpreting these findings the reader has to visualize the given fact that most of the 38 specialized thoracic surgery units in Germany reside outside maximum service and university hospitals [3]. Therefore, it is comprehensible that 53% (226 of 429) of patients with non-iatrogenic tracheobronchial injuries were treated in hospitals that do not provide specialized thoracic surgery services. The majority of these patients (276 of 429; 64%) had developed a tracheobronchial injury following blunt chest trauma and it can be assumed that these patients were transferred to a special trauma unit for treatment of the probably present coexisting injuries [4]. In contrast, 62% patients (374 of 604) with iatrogenic tracheal injuries were treated in specialized thoracic surgery units. This allocation appears reasonable against the background of 38 specialized centres (representing 16% of the reporting institutions) being distributed throughout the country. Here, the supposedly isolated tracheal lesions could be managed in the absence of resource-intensive trauma units.

To cut a long story short, the settling of the (existing or new) specialized thoracic surgery units at Germany’s maximum service and university hospitals may address the detected inadequacies more sustainable than expecting general and trauma surgeons being familiar with sophisticated treatment modalities of thoracic injuries.

References


