Management of Tracheobrochial Injuries: A 10-Year Experience at Ratchaburi Hospital

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Background and Objective: *Tracheobronchial injuries are rare but life threatening. Their successful diagnosis and treatment require a high level of suspicion and early surgical repair. The authors review their experience in managing these injuries over the past 10 years.*
Material and Method: *Patients who were admitted to the Thoracic Surgical Unit, Ratchaburi Hospital and treated for tracheobronchial injuries from 1993 to 2004 were included in the present study. Hospital records were reviewed on mechanism of injury, clinical presentation, diagnosis, management and outcome.*
Results: *The present series comprised of 11 tracheobronchial injury patients. Causal mechanism of injury was 4 blunt and 7 penetrating injuries.*

4 of them with blunt injury, there were 3 right main bronchial disruptions, 1 minor cervical laceration. Presenting signs included dyspnea in 4 and subcutaneous emphysema in 3. 1 of them had massive air leak. Radiographic finding were pneumomediastinum in 3. Pneumothorax in 2, Atelectasis of right lung in 1. All of the right bronchial disruptions had primary repair with reanastomosis in 2 and resection of stenotic bronchus with reanastomosis in 1; this patient developed empyema thoracis with Acinetobacter iwoffii as a result of delayed diagnosis (40day). One patient with minor cervical laceration underwent conservative treatment. All patients with blunt injuries were discharged with a normal patency of airway.

7 patients with penerating injuries, there were 4 cervical, 1 cervical associated with esophageal injury, 1 combined cervical-thoracic type of injuries and 1 Thoracic injury. Presenting signs included dyspnea in 7 and subcutaneous emphysema in 6. The radiographic finding were pneumomediastinum in 5 pneumothorax in 4, one patient underwent tracheal reanastomosis. The rest of six patients underwent immediate primary repairs. One patient with cervical knife stap wound died 4 hours postoperatively of hemoptysis, progressive hypoxia and aneuria, 6 of them were recovered with a normal patency of airway
Conclusion: *The authors concluded that, result of treatment for tracheobronchial injury should depend upon the mechanism of injury, early recognition, early diagnosis and appropriate surgical intervention. Delay in diagnosis is the single most important factor-influencing outcome. Common complications in the early phase were hypoxia, organ failure while in the late phase were sepsis, tracheal or bronchial stenosis, mediastinitis and chronic bronchopleural fistula, etc.*

Keywords: *Tracheobronchial injuries, Major bronchial injury, Bronchial disruption, Tracheal injury*

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Tracheobronchial injuries are rare but potentially life threatening. Many patients die before arrival to the hospital. Some of them are misdiagnosed with multiple injuries. The purpose of the present article was to review the authors' experience with tracheobronchial injuries at Ratchaburi Hospital and to emphasize the need for prompt diagnosis and treatment to avoid lethal complications including severe hypoxic organ failure, sepsis, mediastinitis and bronchopleural fistula.

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Material and Method

Patients with tracheobronchial injury were identified from the Thoracic Unit, Department of Surgery, Ratchaburi Hospital between December 1993 and March 2004. Tracheal and main bronchial injuries were included. Segmental and subsegmental bronchial injuries were excluded. These records were reviewed for mechanism of injury, presentation, diagnosis, management and outcome. Outcome was evaluated in relation to risk factors including mechanism of injury, anatomical location of injury, associated injuries and time interval between injury and diagnosis.

Results

All injuries involved the airway between cricoid cartilage and the secondary bronchial bifurcation. Of the 11 patients treated and divided into groups by the mechanism of injury. The mechanisms of injury were blunt injury from motor vehicle collision in 4 and penetrating injury in 7 (Table 1).

Table 1. Summary of patient data

Patient No.	Age sex	Mechanism of Injury	Airway injury	Treatment	Result	Length of hospitalization (Day) and Remarks	
1	39M	MVA	Cervical trachea right antero-lateral minimal laceration	Conservative	ALIVE Normal airway patency	5	
2	19M	MVA	Right main bronchial disruption	Right thoracotomy reanatomosis with 3-0 Prolene	ALIVE Normal airway patency	9	Fracture ribs 2-3th right chest
3	18M	MVA	Right main bronchial disruption and atelectasis right lung	Right thoracotomy resection of stenotic brochus and reanatomosis with 3-0 Prolene	ALIVE Normal airway patency	11	Delay in diagnosis (40 days)
4	30M	MVA	Right main bronchial disruption	Right thoracotomy reanatomosis with 3-0 Prolene	ALIVE Normal airway patency	15	Multiple rib fracture both sides
5	48M	GSW	Cervical trachea laceration	T incision with median sternotomy debridement and end to end anastomosis with 3-0 Prolene	ALIVE Normal airway patency	24	Right upper lobe lung contusion and fracture of mandible
6	30M	GSW	Cervical trachea	Right neck exploration with partial split sternotomy repair with 3-0 Prolene interposition graft of right common carotid artery	ALIVE Normal airway patency	11	Complete tear common carotid artery, fracture mandible and clavicle
7	50M	GSW	Thoracic trachea Antero-posterior aspect	Right neck exploration with median sternotomy repair with 3-0 Prolene	ALIVE Normal airway patency	13	Two site of tracheal wounds
8	17M	GSW	Posterior cervical trachea and esophagus	Right neck exploration repair both trachea and esophagus with 3-0 Vicryl	ALIVE Normal airway patency T-E Fistula	28	TE fistula healed with conservative treatment
9	50F	KSW	Cervical trachea, Left neck	Left neck exploration repair with 3-0 Prolene	ALIVE Normal airway patency	9	
10	41M	KSW	Left Cervical trachea Right intrathoracic trachea	Right thoracotomy and left neck exploration repair with 3-0 Prolene	ALIVE Normal airway patency	17	Two site of tracheal wounds
11	48F	KSW	Anterior cervical trachea and stab wound left chest	Repair 3-0 Prolene tracheostomy, left thoracotomy wedge resection LUL	DEAD bleeding from tracheostomy, renal shut down	4 hr	Underlying chronic renal failure

MVA = Motor vehicle accident, GSW = Gun shot wound, KSW = Knife stap wound
Blunt injury (No.1-4), Penetrating injury (No.5-11)

Blunt injury: Blunt tracheobronchial injuries were treated in 4 patients (patient No.1-4). 3 had right main bronchial injury with disruption, 1 had minor cervical injury. The mean age was 26.5 years (range 19-39 years), all of them were male. The mean revised trauma score (RTS) was 7.2 with survival probability (ranged 0.96-0.98) (Table 2). Presenting signs included dyspnea in 4 and subcutaneous emphysema in 3. 3 patients were diagnosed by bronchoscopy, using a rigid bronchoscopy in 1 and fiber optic bronchoscopy in 2. One of them (patient No.2) was diagnosed bronchial disruption after thoracotomy by indication of persistent air leak. Three of them had patent airway on arrival to the emergency room, one patient (No.4) intubated before transferring from community hospital. The diagnosis of blunt tracheobronchial injuries (esp. bronchial rupture, or disruption) was based on clinical and radiographic finding of subcutaneous emphysema, falling lung (Fig. 1) and persistent pneumothorax with continuous air leak despite of tube thoracotomy (Table 4). Early diagnosis was made in 3 while one was delayed until 40 days. He developed empyema thoracis with main bronchial stenosis. Surgical repair included 3 reanastomosis of right main stem bronchi (Fig. 3.3, 4.3). Operative approaches included 3 right posterolateral thoracotomies. The procedure of repair consisted of local debridement and suture bronchial wounds using interrupted 3-0 polypropylene (Prolene) with extraluminal knots. All of patients had a normal patency airway and discharged on 9th, 11th and 15th of hospitalization respectively. One patient with minimal air leak received conservative treatment and discharged uneventfully on the fifth day of hospitalization.

Penetrating injury: Penetrating tracheobronchial injuries were treated in 7 patients (patient No.5-11). There were 4 cervical, 1 cervical associated esophageal injury 1 combined cervical-thoracic type of injuries and 1 thoracic injury (Table 1). The mean age was 40.6 years (range 17-50 years) there were 5 male and 2 female. Patients with penetrating injury had a lower revised trauma score (6.4) than previous group with blunt injury (7.2). Presenting signs included dyspnea in 7 and subcutaneous emphysema in 6, 3 patients with GSW were diagnosed by fiber optic bronchoscopy for located site of injury. The rest were diagnosed by physical examination in 3 and intraoperative examination in 1. Physical and intraoperative examination diagnosed all of patients with penetrating injury from knife stap wound (Table 3).

5 patients had patent airway on arrival to the emergency room. 2 of them were intubated before referring from community hospital. One patient intubated from oral route (patient No.6) and other intubated from distral tracheal route after mini-exploration at the anterior aspect of the neck (patient No.5). The radiographic finding were subcutaneous emphysema in 6, mediastinal emphysema in 5, pneumothorax in 4 (Table 4). Of the 7 patients with penetrating injury,

Table 3. Mechanism of injury versus method of diagnosis

Method of confirming Diagnosis	Blunt		GSW	KSW
	Trachea	Bronchus	Trachea	
Physical examination			1	2
Rigid bronchoscopy		1		
Fiberoptic bronchoscopy	1	1	3*	
Intraoperative examination		1		1

*One associated with esophageal perforation

Table 2. Primary survey finding and final result

Patient No.	Blunt injury				Penetrating injury							Average
	MVA				GSW				KSW			
	1	2	3	4	5	6	7	8	9	10	11	
RTS in Blunt Trauma	7.8	6.6	7.8	6.6								7.2
RTS in Penetrating Trauma					5.2	5.4	7.8	6.9	7.8	7.8	4.2	6.4
Endotracheal Intubation				X	X	X						
Survival Probability	0.98	0.96	0.98	0.96	0.80	0.80	0.98	0.96	0.98	0.98	0.60	
Result	S	S	S	S	S*	S	S	S*	S	S	D	

RTS = Revised trauma score, (Normal 0-8), calculated with Glasgow coma score, respiratory rate and blood pressure
* = Complication with left vocal cord paralysis
MVA = Motor vehicle accident, GSW = Gun shot wound, KSW = Knife stab wound
S = Survival, D = Death, X = Endotracheal intubation before arrival to emergency room

Table 4. Chest radiographic findings in 11 patients

Findings	Patient No.											Total
	MVA				GSW					KSW		
	1	2	3	4	5	6	7	8	9	10	11	
Anatomical location	C	T	T	T	C	C	T	C	C	CT	C	
Pneumothorax		+ Te		+ B	+		+ Te			+	+ Te	6
Pneumomediastinum	+	+		+	+		+	+	+	+		8
Atelectasis			+ D									1
Subcutaneous emphysema	+	+		+	+	+		+	+	+	+	9
Rib fracture		+		+								2
Pulmonary contusion		+		+	+							3
Widened mediastinum							+					1
Hemothorax					+						+	2

C = Cervical part, T = Thoracic part, CT = Cervical and thoracic part, Te = Tension pneumothorax, B = Bilateral pneumothorax, D = Delay in diagnosis (40 days) (previous right pneumothorax)
Patient No.3 delayed in diagnosis with total right lung atelectasis
Patient No.5 associated with GSW right upper lobe
Patient No.11 combined with stab wound left chest
Blunt injury (No.1-4), Penetrating injury (No.5-11)

diagnosis was made promptly then primary repair and debridement was performed. Surgical repair included 1 reanastomosis of lower cervical trachea and 6 primary suture of the trachea. Operative approaches included 3 median sternotomies and neck explorations, 2 neck explorations, 1 right posterolateral thoracotomy and left cervical exploration and 1 left anterolateral thoracotomy, neck exploration and tracheostomy (Table 1). The procedure of repair consisted of local debridement and suture of the tracheal wounds using interrupted polypropylene (Prolene) in 6 patients and 3-0 polyglactin (Vicryl) in 1 patient (No.8). The operations were performed successfully in 6 patients and then they were discharged with a normal patency of airway. There was 1 death;This patient with stap wound of the neck and left chest (No.11) died 4 hours postoperatively of progressive hypoxia and massive bleeding as a result the left upper lobe injury and chronic renal failure. Only one patient (No.8) developed tracheo-esophageal fistula which completely healed by conservative treatment twenty-eight days later. Two patients had left vocal cord paralysis as a result of recurrent laryngeal nerve injury, which one associated tracheal disruption and esophageal perforation in the other. They were discharged home on the twenty-fourth and twenty-eight day respectively with normal swallowing.

Discussion

Tracheobronchial injuries (TBIs) had been considered fatal until Krinitzki[1] reported the case of a human long-term survivor in 1927. Twenty years later Kinsella and Johnstrud[2] reported the first successful primary repair of a bronchial rupture caused by blunt trauma. The true incidence of TBI is difficult to establish, as a large proportion (30-50%) of these patients will die before arrival to the hospital[3]. However, it is estimated on the autopsy reports that 2.5-3.2% of patients who die as a result of trauma may have associated TBI.

The initial assessment of major airway injuries involved the traditional ABCs of resuscitation as outlined in the advanced trauma life support guideline[4]. Patients with TBIs require urgent control of the airway, evacuation of blood and air from the pleural space by intercostal drainage. Orotracheal intubation was the most frequent method to control the airway.

Blunt injury: The common initial physical findings in 4 patients (No.1-4) with blunt TBIs were dyspnea and subcutaneous emphysema. All 4 patient had dyspnea, 3 of them had subcutaneous emphysema. One had found an evidence of massive air leak despite tube thoracostomy. Diagnosis of blunt TBIs depends on physical finding of dyspnea, subcutaneous emphysema. pneumothorax and cyanosis. Baumgartner et al[5] regarded subcutaneous emphysema and dyspnea as the most consistent presenting features[6-8].

Pneumomediastinum was the most common radiographic finding (3 of 4 patients). Pneumothorax was found in 2 patients, 1 of which were involved bilaterally. Two patients (No.2, 4) with radiographic changes resembling the "fallen lung sign" (Fig. 1) had complete right bronchial disruption. One patient (No.3) with complete main bronchial disruption presented with total atelectasis of the right lung (Fig. 3.1). This deceptive sign, the chest radiograph showing atelectasis, took the authors 40 days to reach the correct diagnosis.

Kirsh et al[9] postulated three mechanisms of TBI in blunt trauma. The first involves rapid compression of the chest and the anteroposterior diameter of the thorax with a simultaneous widening of the transverse diameter. This produces lateral motion resulting in traction on the trachea at the carina. The second

mechanism involves an increase in the intraluminal pressure then exceeds the tracheal elastic strength, which results in rupture at the membranous and cartilaginous junctions. In the third mechanism, rapid deceleration results in shearing forces at fixed points along the trachea, including the cricoid cartilage and the carina, leading to disruption. The authors found in 3 out of 4 patients with TBIs due to blunt trauma, the right main bronchi were disrupted at 0.5, 1 and 1 cm below the carina. They all had associated rib or clavicle fractures. Bronchoscopy was the most useful and accurate method to confirm TBIs. Bronchoscopy was performed in 3 of 4 patients (Table 3) using rigid bronchoscopy in 1 and fiber optic bronchoscopy in 2. Bronchoscopic finding were bronchial stenosis in 1 (Fig. 3.2) bronchial disruption in 2 and small cervical tracheal wound in 1. One patient with disruption of bronchus underwent emergency thoracotomy as a result of massive air leak without bronchoscopy. At operation, we used one-lung ventilation by pushing the tip endothacheal tube into left main bronchus.

A chest spiral computed tomographic scan may be used in stable patients and demonstrated and abnormal cause of a mainstem bronchus or a "fallen lung" sign, featuring a collapsed lung in a dependent position, hanging on the hilum only by its vascular attachment[10]. In chronic case of TBIs, CT chest should demonstrated a consolidation of lung, a pleural effusion as a report of Ozcelik et all[11].

Once a diag of TBI was made, the surgical management included open debridement and repair to estabilish airway continuty[12-15]. Lynn lyenger[16] reported that more than 80% of TBIs due to blunt trauma are locuted with in 2.5 cm of the carina. This report similar to our report 3 patients (No.5-7) had right main bronchial disruption at 05-1 cm below cervical and 1 patient had cervical laceration. The authors operated all of 3 patients with rupture bronchi via right thoracotomy and anastomosis with non-absorbable sutures (polyprolene) which were used interrupted with extraluminal knots (Fig. 3.3). The remainder of one patient underwent conservative treatment. All of them discharged with a normal patency of airway (Fig. 2, 4.1, 4.2, 4.3).

Penetrating injury: Most of penetrating TBIs were located in the cervical trachea at Zone I of the neck between clavicle and cicoid cartilage. The initial physical findings were dyspnea in 7 and subcutaneous emphysema in 6. Diagnosis of penetrating TBIs depends on history and physical examination with careful inspection of the site of injury for evidence

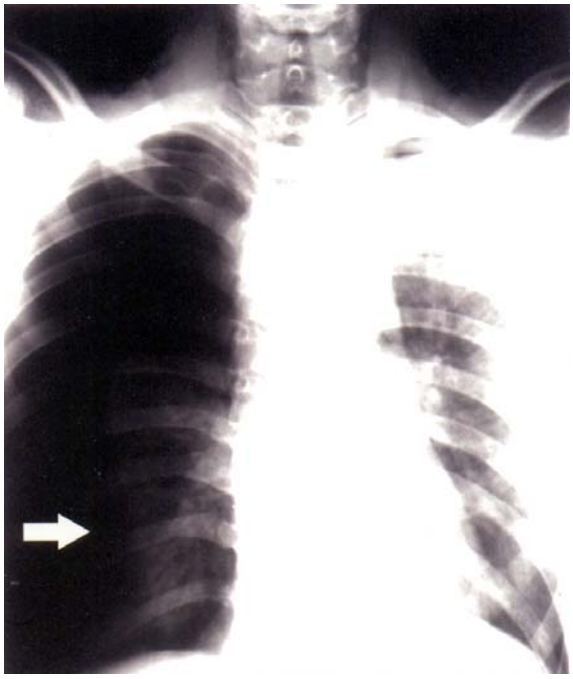

Fig. 1 Falling lung (white arrow) with pneumothorax (patient No.2)

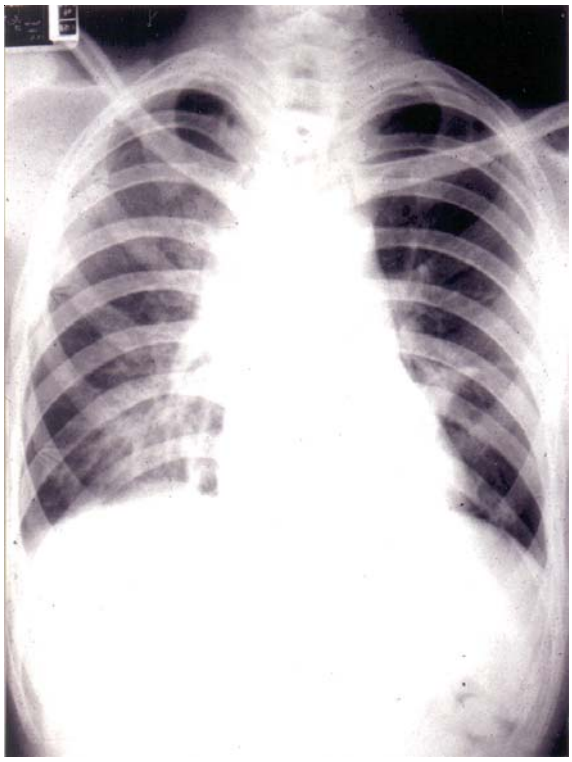

Fig. 2 CXR after operation (patient No.2)

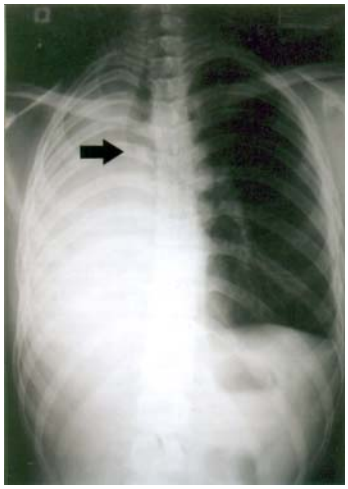

Fig. 3.1 Preoperative CXR finding of the patient No.3 with total right lung atelectasis and main bronchial disruption (black arrow)

Fig. 4.1 CXR finding revealed complete right lung expansion after operation (patient No.3)

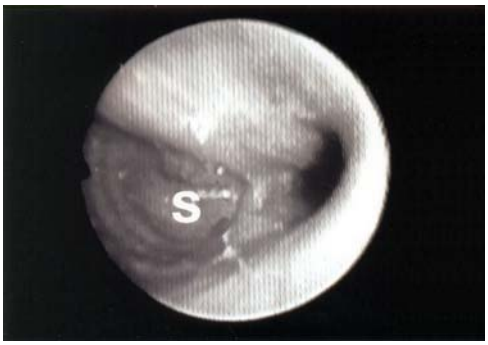

Fig. 3.2 Preoperative bronchoscopic finding with right main bronchial stenosis(S) (patient No.3)

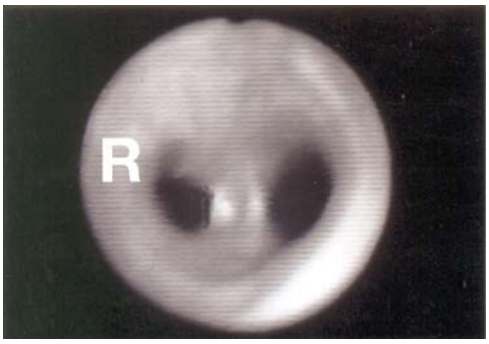

Fig. 4.2 Postoperative bronchoscopic finding with normal of airway continuity (R= right main bronchus) (patient No.3)

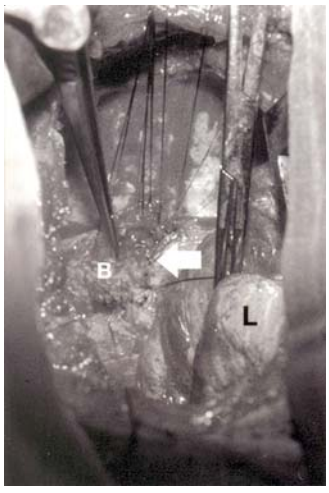

Fig. 3.3 Resection and reanastomosis of disruption the right main bronchus (white arrow) at fortieth day after injury (patient No.3)
B = Right main bronchus, L= Ateletasis of right lung

Fig. 4.3 Complete right lung expansion after operation (patient No.3)

of air leaking in the cervical region[17]. Pneumomediastinum was the most common chest radiographic finding;in was found 5 of 7 patients. Pneumothorax was found in 4, 3 of which associated to intrathoracic injury (Table 4). One patient with cervical tracheal nearly disruption had left pneumothorax due to GSW.

Fiber optic bronchoscopy was performed in 3 patients with penetrating injury due to GSW to confirm in diagnosis. 4 patients were operated without bronchoscopy because of unstable hemodynamic status in 1, air bubling through the neck wound in 2, previously distal trachial intubation in 1. There was one remarkable patient (patient No. 5) with penetrating injury due to GSW who referred to us from a community hospital with a nearly complete tracheal transection. On examination revealed the direction of GSW from left scapular (in let) to suprasternal nocth (out let) and the right angle of mandible. He arrived after neck wound exploration with an endotracheal tube (No. 6) inserted in to the distal tracheal opening. At the operation the authors found severe laceration at left antero-lateral aspect of trachea, esophagus was intect. The authors started with primary repair of the posterior tracheal wall, inserted another endotracheal tube through a nostril. While the tube was slowly pushed down the upper portion of the trachea the authors were ready to grasp its end and guide it further down the lower part. Primary repair was then continued on the anterior tracheal wall.

The penetrating TBIs should depend upon type, size and site of the wound and the coexistent injury along the direction of the penetrating wound. In the authors' review, of 7 patients with TBIs had all tracheal injury. The site of injuries were 5 cervical, 1 thoracic and 1 combined cervical-thoracic. Most cervical tracheal injuries were approached by neck exploration with or without median sternotomy. Median sternotomy was performed in patients with injuries high in mediastinal and lower cervical trachea (patient No.5-7). Thoracotomy should be performed in one patient with knife stap wound at left neck after neck exploration. She had an ipsilateral pneumothorax (patient No.10) and right thoracotomy was performed with primary repair of the thoracic trachea. This report, associated injuries form penetrating injury included 1 esophageal perforation, 2 vocal cord paralysis, 2 fracture of the mandible, 1 complete tear of right common carotid artery. In the present report, esophageal perforation was found in 1 of 7 patients (14.3%), whereas, there was 30% in other report by Symbas PN[12]. The authors prefer non-absorbable sutures (polypropylene) for interrupted sutures with extraluminal knots in 6 of 7 patients with penetrating injury. One patient had tracheoesophageal fistula following absorbable suture, the fistula healed completely after conservative treatment. 6 of 7 patients discharge with normal patency of airway. One patient died form hemoptysis dyspnea and chronic renal failure.

Complex TBIs: Cardiopulmonary bypass was used only for the repair of the complex TBIs including a combination of various sites of posterior trachea and main bronchus, longitudinal rupture and bilateral rupture of brochi. The other complex lesion such as the rupture brochus and false aneurysm of pulmonary artery was operated with standby cardiopulmonary bypass[18].

Conclusion

The authors conclude that early recognition with a high index of suspicion of TBIsmust be attained to detect these rare life threatening lesions[19,20]. Clinical presentation including subcutaneous emphysema, dyspnea, tachypnea, air leak at the neck, pneumothorax, pneumomediastinum falling lung should be suspicious of TBIs. Treatment of TBIs depends upon the mechanism of injury, early diagnosis and appropriate surgical intervention. Early treatments minimize the risk of infection, pulmonary resection and short hospitalization. Delayed diagnosis is the most important factor impeding outcome, and leading to complications such as stenosis of the bronchus by obstructing granulation tissue, empyema thoracis and sepsis.

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การรักษาการบาดเจ็บหลอดลมและแขนงหลอดลมส่วนต้น: ประสบการณ์ 10 ปีในโรงพยาบาลราชบุรี

ชนินทร์ กลิ่นจงกล, บุษบา ภักดีรัตน์

วัตถุประสงค์*: เพื่อศึกษาการบาดเจ็บหลอดลม (trachea)และแขนงหลอดลมใหญ่ (main bronchus) ในรอบ 10 ปี ย้อนหลัง ภาวะบาดเจ็บหลอดลมพบได้น้อยแต่เป็นอันตรายถึงชีวิต ซึ่งต้องการการวินิจฉัยอย่างถูกต้อง และได้รับการรักษาโดยการผ่าตัดในระยะแรก*

วิธีการ*: การศึกษาย้อนหลังในผู้ป่วยที่ได้รับอุบัติเหตุของงานศัลยกรรมทรวงอกระหว่าง พ.ศ. 2536-2547 ศึกษาสาเหตุการบาดเจ็บ อาการแสดง การวินิจฉัยโรค การรักษาผู้ป่วย ตลอดจนผลของการรักษา*

ผลของการศึกษา*: พบว่ามีผู้ป่วย 11 ราย ได้รับบาดเจ็บที่หลอดลมและแขนงหลอดลมแยกตามสาเหตุดังนี้ สาเหตุจากอุบัติเหตุรถยนต์ 4 ราย จากกระสุนปืน 4 รายและมีด 3 ราย อาการแสดงที่พบบ่อยคือมี ลมรั่วในชั้นใต้ผิวหนัง (subcutaneous emphysema) และมีอาการหายใจหอบเหนื่อย(dyspnea) จากภาพรังสีพบลมในช่องอก (pneumomediastinum) และลมรั่วในช่องปอด (pneumothorax) ผู้ป่วย 4 รายสาเหตุจากอุบัติเหตุรถยนต์ (blunt injury) พบว่าได้รับบาดเจ็บแขนงหลอดลมปอดด้านขวาขาด (right main bronchus) 3ราย ให้การวินิจฉัยล่าช้า 1 ราย ทำให้ติดเชื้อในช่องปอด ซึ่งทั้ง 3 ราย ได้รับการรักษาโดยการผ่าตัดต่อแขนงหลอดลมด้านขวา และอีก1 ราย ซึ่งบาดเจ็บที่หลอดลมบริเวณคอ (cervical trachea) ได้รับการรักษาแบบประคับประคอง ผลการรักษาผู้ป่วยทุกรายหายเป็นปกติ ส่วนผู้ป่วย 7 ราย ที่ได้รับบาดเจ็บจากวัตถุมีคม (penetrating injury) พบว่าบาดเจ็บบริเวณหลอดลมส่วนคอ 5 ราย ส่วนอก 1 ราย ส่วนคอและส่วนอกร่วมกัน 1 ราย ผู้ป่วยทั้ง 7 รายนี้ ได้รับการรักษาโดยการผ่าตัดต่อหลอดลม 1 ราย โดยการผ่าตัดซ่อมแซม 6 ราย มีผู้ป่วยเสียชีวิต 1 ราย หลังผ่าตัด 4 ชม. สาเหตุจากเลือดออกไม่หยุดในทางเดินหายใจ และมีภาวะไตวายร่วม อัตราตายรวมทุกสาเหตุ 9.1%*

สรุป*: การรักษาผู้ป่วยในภาวะการบาดเจ็บหลอดลมและแขนงหลอดลมขึ้นอยู่กับสาเหตุ การวินิจฉัยได้ทันท่วงที การรักษาอย่างถูกต้องและรวดเร็ว ผู้ป่วยบางรายอาจเสียชีวิตได้ในการรักษาระยะแรกจากภาวะขาดออกซิเจนจากทางเดินหายใจอุดตัน การล้มเหลวของระบบสมอง หัวใจและไต ฯลฯ การวินิจฉัยล่าช้าทำให้เกิดภาวะแทรกซ้อนจากการติดเชื้อในกระแสเลือด การติดเชื้อในช่องเยื่อหุ้มปอด ภาวะอุดตันของหลอดลม จาก granulation tissue ได้*