Pneumomediastinum following blunt trauma: Worth an exhaustive workup?

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BACKGROUND: Incidental pneumomediastinum is a common radiologic finding following blunt thoracic injury; however, the clinical significance of pneumomediastinum on screening imaging is poorly defined (*Curr Probl Surg*. 2004;41(3):211–380; *Injury*. 2010;41(1):40–43). The purpose of this study was to define the incidence of aerodigestive injuries in patients with pneumomediastinum after blunt thoracic and neck injury.

METHODS: After institutional review board approval was obtained, a retrospective review was performed of all patients admitted to Los Angeles County + University of Southern California Medical Center with blunt neck and/or thoracic injuries between January 2007 and December 2012. All patients with pneumomediastinum on radiologic investigation were included. Data accrued included demographics, admission clinical data, injury severity patterns, incidence of aerodigestive injuries, operative findings, morbidity, mortality, as well as intensive care unit and hospital lengths of stay.

RESULTS: A total of 9,946 patients were included in the study. The predominant mechanism was motor vehicle collision (49%), disproportionately male (76%). Overall, 258 patients (2.6%) had a pneumomediastinum: 65 (25%) and 193 (75%) were diagnosed on a chest x-ray or on a computed tomography (CT) scan, respectively. A total of 21 patients (8.1%) had an aerodigestive workup with bronchoscopy, esophagram, and/or esophagoscopy. Overall, four aerodigestive lesions (1.6%) were diagnosed. Three tracheobronchial injuries were identified on CT scan, and one esophageal injury was diagnosed on an esophagram. Two tracheobronchial injuries required surgery, while the remaining cases were managed nonoperatively. The overall mortality in this cohort was 10.9%.

CONCLUSION: Isolated findings of pneumomediastinum on screening chest x-ray or CT following blunt trauma is a poor predictor of an aerodigestive injury. Highly selective workup in this clinical setting is warranted. (*J Trauma Acute Care Surg*. 2015;79: 188–193. Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Prognostic/epidemiologic study, level III; therapeutic study, level IV.

KEY WORDS: Pneumomediastinum; blunt trauma; thoracic trauma; neck trauma; aerodigestive injuries.

The incidence of pneumomediastinum is noted to be as high as 10% after chest trauma and can be associated with significant mortality caused by the delayed recognition of significant aerodigestive tract injuries.[1,2] The associated severity of a missed esophageal or tracheobronchial injury renders pneumomediastinum as a significant finding in the workup of trauma patients, which cannot be ignored. Historically, the incidence of pneumomediastinum has been described as 4% to 10% after blunt thoracic trauma, and a recent study found the incidence of aerodigestive injuries after blunt thoracic and cervical trauma to be 7%.[1,3]

However, the workup for incidental pneumomediastinum on screening chest x-ray (CXR) or computed tomography (CT) remains to be defined. This is particularly important because the routine use of CT imaging in the evaluation of blunt trauma patients has led to an increased incidence of pneumomediastinum because of CT's higher sensitivity and improved generation of CT scanners.[1] Overtriage of pneumomediastinum may lead to an increased incidence of unnecessary invasive workup and lead to an increased cost burden due to prolonged hospitalization. We hypothesize that incidental pneumomediastinum identified on screening CXR or CT does not frequently associate with aerodigestive injury. Our specific aim was to identify the frequency of pneumomediastinum in a retrospective cohort of blunt thoracic and neck trauma patients and correlate the finding with the true presence of an aerodigestive injury.

METHODS

After institutional review board approval was obtained, all patients admitted to Los Angeles County + University of Southern California Medical Center who experienced blunt trauma to the thorax and/or neck with pneumomediastinum diagnosed by CXR and/or CT scan over a 6-year study period (January 2007 to December 2012) were retrospectively identified. All imaging studies and radiologic reports during that period were queried for radiographic findings of

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TABLE 1. Univariate Analysis

	Total	Alive	Dead	*p*
Age median (IQR)	33 (22–51)	32 (22–48)	49 (28–61)	0.008
Male, n (%)	196 (76)	172 (74.8)	24 (85.7)	0.201
Mechanism of injury, n (%)				
MVC	95 (36.8)	87 (37.8)	8 (28.6)	0.252
MCC	32 (12.4)	31 (13.5)	1 (3.6)	0.252
Fall	47 (18.2)	39 (17)	8 (28.6)	0.252
AVP	42 (16.3)	35 (15.2)	7 (25)	0.252
Assault	19 (7.4)	18 (7.8)	1 (3.6)	0.252
Other	23 (8.9)	20 (8.7)	3 (10.7)	0.252
Subcutaneous emphysema, n (%)	158 (61.2)	136 (59.1)	22 (78.6)	0.046
Pneumothorax, n (%)	186 (72.1)	164 (71.3)	22 (78.6)	0.508
Hemothorax, n (%)	97 (37.6)	82 (35.7)	15 (53.6)	0.065
Rib fracture, n (%)	159 (61.6)	138 (60)	21 (75)	0.123
Sternal fracture, n (%)	24 (9.3)	22 (9.6)	2 (7.1)	1.000
Pulmonary contusion, n (%)	129 (50)	112 (48.7)	17 (60.7)	0.230
Field Intubation, n (%)	14 (5.4)	4 (1.7)	10 (35.7)	<0.001
Field GCS score ≤ 8, n (%)	70 (27.1)	50 (21.7)	20 (71.4)	<0.001
ED GCS score ≤ 8, n (%)	70 (27.1)	48 (20.9)	22 (78.6)	<0.001
HR ≥ 120, n (%)	70 (27.1)	61 (26.5)	9 (32.1)	0.528
SBP < 90, n (%)	17 (6.6)	11 (4.8)	6 (21.4)	0.005
ISS ≥ 25, n (%)	97 (37.6)	75 (32.6)	22 (78.6)	<0.001
Chest tube placed, n (%)	107 (41.5)	87 (37.8)	20 (71.4)	0.001
ED thoracotomy, n (%)	4 (1.6)	3 (1.3)	9 (32.1)	<0.001
Exploratory thoracotomy, n (%)	17 (6.6)	8 (3.5)	9 (32.1)	<0.001
Aerodigestive injuries, n (%)	4 (1.6)	3 (1.3)	1 (3.6)	0.370

AVP, auto versus pedestrian; MCC, motorcycle collision; MVC, motor vehicle collision.

pneumomediastinum or mediastinal air. Cases with missing or incomplete data were excluded from the analysis.

The patient records including demographic data, physical examination and laboratory findings, radiographic information, and procedural data were reviewed for the presence of esophageal or tracheobronchial injuries.

From the trauma record, the following data were extracted: age, sex, blunt mechanism of injury, Glasgow Coma Scale (GCS) score in the field, systolic blood pressure (SBP), heart rate (HR), GCS score upon arrival to the emergency department (ED), level of activation, Injury Severity Score (ISS), as well as clinical and radiologic findings associated with thoracic trauma including subcutaneous emphysema, the presence of a pneumothorax, hemothorax, rib fractures, sternal fractures, and pulmonary contusions. Clinically significant cutoff values were used for quantitative variables such as hypotension (SBP < 90), tachycardia (HR ≥ 120), field and ED GCS scores of 8 or less, and ISS of 25 greater. The reports of esophagoscopies, bronchoscopies, as well as barium and water-soluble contrast agent Gastrografin (Schering, Berlin, Germany) esophagrams were also reviewed. The primary outcome was a diagnosis of an aerodigestive injury, and secondary outcomes included hospital length of stay (LOS), intensive care unit (ICU) LOS, ventilator days, and in-hospital mortality.

Descriptive statistical analysis was performed for the entire study population (Table 1). Categorical variables were reported as percentages and continuous variables as median and interquartile range (IQR: Q1, Q3). Bivariate analysis was performed using χ^2 or Fisher's exact test as appropriate to test differences in proportions and Kruskal-Wallis test to compare differences between medians. All analyses were performed using the SPSS Windows, version 17.0 (SPSS Inc., Chicago, IL).

RESULTS

A total of 9,946 cases with blunt thoracic and/or neck trauma were included. Of these, 718 patients had significant radiographic findings of pneumomediastinum on screening CXR and/or CT scan. After review of radiographic data, a total of 258 patients (2.6%) were confirmed to have a pneumomediastinum present. Of those, 65 (25%) were diagnosed on CXR and 193 (75%) on a CT scan of the chest. The majority of cases sustained their injuries after a motor vehicle collision (n = 95, 36.8%) or a motorcycle collision (n = 32, 12.4%); falls (n = 47, 18.2%) and auto versus pedestrian (n = 42, 16.3%) were other frequent mechanisms of injury, followed by assaults with blunt instrument (n = 19, 7.4%) and other mechanisms (n = 23, 8.9%) resulting in blunt trauma. Males were predominantly affected (n = 196, 76%), with a median (IQR) age of 33 (22–51) for the entire group. Demographic data are presented in Table 2.

TABLE 2. Comparison of Patients With and Without Aerodigestive Injuries

	Total (n = 258)	No Aerodigestive Injuries (n = 254)	Aerodigestive Injuries (n = 4)	*p*
Age median (IQR)	33 (22–51)	33 (22–51)	38 (21–56)	0.901
Male, n (%)	196 (76)	193 (76)	3 (75)	1.000
Mechanism of injury, n (%)				
MVC	95 (36.8)	93 (36.6)	2 (50)	0.607
MCC	32 (12.4)	32 (12.6)	0	0.607
Fall	47 (18.2)	47 (18.5)	0	0.607
AVP	42 (16.3)	40 (15.7)	2 (50)	0.607
Assault	19 (7.4)	19 (7.5)	0	0.607
Other	23 (8.9)	23 (9.1)	0	0.607
Subcutaneous emphysema, n (%)	158 (61.2)	156 (61.4)	2 (50)	0.642
Pneumothorax, n (%)	186 (72.1)	185 (72.8)	1 (25)	0.067
Hemothorax, n (%)	97 (37.6)	96 (37.8)	1 (25)	1.000
Rib fracture, n (%)	159 (61.6)	158 (62.2)	1 (25)	0.159
Sternal fracture, n (%)	24 (9.3)	24 (9.4)	0	1.000
Pulmonary contusion, n (%)	129 (50)	127 (50)	2 (50)	1.000
Field intubation, n (%)	14 (5.4)	13 (5.1)	1 (25)	0.222
Field GCS score ≤ 8, n (%)	70 (27.1)	67 (26.4)	3 (75)	0.075
ED GCS score ≤ 8, n (%)	70 (27.1)	68 (26.8)	2 (50)	0.298
HR ≥ 120, n (%)	70 (27.1)	69 (27.2)	1 (25)	1.000
SBP < 90, n (%)	17 (6.6)	17 (6.7)	0	1.000

AVP, auto versus pedestrian; MCC, motorcycle collision; MVC, motor vehicle collision.

TABLE 3. Diagnostic Workup and Therapeutic Interventions for Patients With and Without Aerodigestive Injuries

	Total (n = 258)	No Aerodigestive Injuries (n = 254)	Aerodigestive Injuries (n = 4)	*p*
Identified on				
CXR, n (%)	65 (25.2)	64 (25.2)	1 (25)	1.000
Chest CT, n (%)	193 (74.8)	190 (74.8)	3 (75)	1.000
Further workup, n (%)				
Esophagoscopy	2 (0.8)	2 (0.8)	0	1.000
Bronchoscopy	7 (2.7)	6 (2.4)	1 (25)	0.105
Gastrografin swallow	6 (2.3)	5 (2)	1 (25)	0.090
Barium swallow	7 (2.7)	7 (2.8)	0	1.000
Injury severity, n (%)				
ISS ≥ 25	97 (37.6)	95 (37.4)	2 (50)	0.633
Interventions, n (%)				
Chest tube placed	107 (41.5)	106 (41.7)	1 (25)	0.642
ED thoracotomy	11 (4.3)	10 (3.9)	1 (25)	0.161
Exploratory thoracotomy	17 (6.6)	16 (6.3)	1 (25)	0.240
LOS, median (IQR)	9 (4–21)	9 (4–21)	8 (3–32)	0.753
ICU LOS, median (IQR)	7 (4–18) (185)	7 (4–18) (181)	3 (2–18) (4)	0.157
Ventilator days	8 (3–14) (96)	8 (4–14) (95)	1 (1–1) (1)	0.120
Mortality, n (%)	28 (10.9)	27 (10.6)	1 (25)	0.370

For ICU LOS and ventilator days, the absolute number of patients is included in parentheses next to the IQRs.

The injury distribution is further summarized in Table 3. Pneumothorax, rib fractures, and pulmonary contusions were identified in half or more of this population, with 107 (41.5%) having a chest tube placed. In the field, 5.4% required intubation, and upon presentation to the ED, 27% had a GCS score of 8 or less, with 6.6% being hypotensive. Overall, 21 patients (8.1%) were further investigated with bronchoscopy, esophagoscopy, esophagram, or a combination of these, confirming four cases with clinically significant aerodigestive injuries, three tracheal injuries, and one esophageal injury, respectively. Two of the tracheal injuries were sustained during airway manipulation during resuscitation in the ED (Table 4). Of the aerodigestive injuries, all tracheal injuries were diagnosed on a CT, whereas the sole esophageal injury was identified on esophagram. Median ISS was 21 (IQR, 14–29), with 97 (37.6%) having an ISS of 25 or greater. In the operative arm, 17 (6.6%) underwent thoracotomy, 11 of which were resuscitative thoracotomies performed in the ED.

The overall mortality of this population was 10.9% (28 of 258), with median LOS of 9 (IQR, 4–21). Overall, 185 patients (71.7%) required ICU admission, with median ICU LOS of 7 days (IQR, 4–18 days), and 96 patients (37.2%) with pneumomediastinum experienced respiratory failure requiring intubation as a complication, with a median of 8 days (IQR, 3–14 days) on the ventilator.

DISCUSSION

In this retrospective 6-year cohort of blunt thoracic and neck trauma patients, the overall rate of pneumomediastinum was found to be 2.6%. Previous reports have shown a range of 4.1% to 10%.[1,3] With increased availability and use of high-resolution CT imaging, this number is expected to increase. In the vast majority of patients, pneumomediastinum is not associated with aerodigestive injuries; however, it has been shown to be a sign of high injury burden after blunt trauma and carry a significant mortality, making a missed injury a significant concern as a result of insufficient diagnostic workup. Conversely, overtriage of pneumomediastinum may involve unnecessary further diagnostic workup and be associated with potential patient complications and incurred hospital costs.

In our study, two of the three tracheal injuries were a result of iatrogenic injuries during resuscitation. One injury occurred during surgical cricothyroidotomy and the other during translaryngeal intubation. Instrumentation has been shown to be a statistically significant predictor of airway and esophageal injuries.[4] Although a controversial strategy, conservative management of aerodigestive injuries has been shown to be effective regardless of the mechanism of injury.[5] Both of these iatrogenic injuries were conservatively treated with no adverse events.

In patients with thoracic injuries, the distribution was composed of pneumothorax (72.1%), rib fractures (61.6%), and pulmonary contusions (50%), with hemothorax and sternal fractures composing of fewer injuries. The association between pneumothorax and pneumomediastinum as well as the Macklin effect has been described in several articles including the

TABLE 4. Aerodigestive Injuries in the Study Population

	Injury	CT Identified	Bronchoscopy	Esophagoscopy	Gastrografin Swallow	Barium Swallow	Management	Disposition
Case 1: 20 y, male, AVP	Tracheal injury	Identified	0	0	0	0	Cricothyroidotomy	Home
Case 2: 51 y, male, MVC	Esophageal injury	Missed	0	0	1	0	Cricothyroidotomy	Home
Case 3: 25 y, female, MVC	Tracheal Injury (intubation)	Identified	1	0	0	0	Open tracheostomy	Rehabilitation
Case 4: 57 y, male, AVP	Tracheal injury (cricothyroidotomy)	Identified	0	0	0	0	EDT	Morgue

AVP, auto versus pedestrian; EDT, ED thoracotomy; MVC, motor vehicle collision.

article of Wintermark and Schnyder.[6] In these instances, a pneumomediastinum occurs as result of laceration of mediastinal pleura allowing dissection of air from the severed chest cavity into the mediastinum or from the disruption of alveoli due to a sudden increase of the intrathoracic pressure leading to air tracking towards the mediastinum along the bronchovascular planes. However, in our population, both cases with aerodigestive injuries related to the initial trauma did not show presence of a pneumothorax or the typical radiologic signs of the Macklin effect. Thus, the presence of isolated pneumomediastinum should particularly raise suspicion for an aerodigestive injury in the setting of blunt trauma.

The workup of pneumomediastinum in the setting of severe blunt thoracic and neck trauma is controversial. In approximately 25% of cases, the diagnosis of pneumomediastinum is made initially on screening CXR; however, CT is a much more sensitive and specific imaging modality in thoracic trauma.[1,7] In our study, 21 cases (8.1%) had additional diagnostic interventions performed on the basis of a screening imaging study that was positive for pneumomediastinum. All of the tracheal injuries were identified in CT imaging, but the sole esophageal injury was missed on CT scan. In one pediatric series with blunt thoracic trauma, 28 diagnostic procedures were performed in 32 cases, with only 1 yielding positive findings.[8] In another article, 60% of blunt thoracic and cervical trauma cases never had endoscopic or esophagographic evaluation with no missed injuries or adverse events.[1] It would seem, based on these case series, that performing procedures to reliably rule out significant aerodigestive tract injury when screening imaging studies (CXR, CT) are positive for pneumomediastinum may be unnecessary because they do not always identify more injuries or improve outcomes. In our study cohort, after prospective and continuous review of the morbidity and mortality by a panel of attending trauma surgeons and fellows, there were no missed injuries among the cases that did not undergo a full workup.

Moreover, although esophageal injuries are notorious for being diagnostically challenging, they are exceedingly rare after blunt trauma. In our study, the esophageal injury even though not definitively diagnosed on CT imaging, the read was notable for retropharyngeal prevertebral air, suggestive of esophageal perforation. On esophagram a midesophageal perforation just below the level of the aortic arch was identified, which was managed conservatively without complications. In this circumstance, although a more aggressive diagnostic algorithm was used, it did not necessarily lead to further therapy.

Conversely, some studies have advocated a more aggressive approach to diagnostic workup. Some studies raise caution for the diagnosis of esophageal injuries after blunt trauma, especially in the setting of a suspicious CT scan. In such cases, further workup with esophagram is mandated to avoid missing an esophageal injury.[9–11]

The strikingly low incidence of aerodigestive injuries in this cohort of patients with pneumomediastinum, despite the high injury burden with 37.6% having an ISS of 25 or greater, is in accordance with previous reports in the literature.[12] Therefore, the presence of pneumomediastinum as a proxy for aerodigestive tract injury remains controversial. To minimize missed injuries and avoid unnecessary investigations, patient selection was based on a range of clinical symptoms and signs in conjunction with the radiologic findings. Hemoptysis, odynophagia, marked hoarseness, unexplained dyspnea, the need for an emergent airway, and depressed mental status were considered worrisome findings in the presence of pneumomediastinum. Even though the quantification of pneumomediastinum was not possible in this study, both the amount and the location of the air locules were useful adjunct findings. Because of the small number of aerodigestive injuries observed, an attempt to identify independent predictors of aerodigestive injuries did not yield any significant results.

The finding of pneumomediastinum after blunt trauma should serve as an indicator for a highly selective workup based on the very low incidence of aerodigestive injuries. A higher index of suspicion and a lower threshold for further evaluation are indicated for the workup of suspected esophageal injuries.

CONCLUSION

Isolated findings of pneumomediastinum on screening CXR or CT following blunt trauma is a poor predictor of an aerodigestive injury. Highly selective workup in this clinical setting is warranted.

AUTHORSHIP

K.C., E.B., P.T., and D.D. designed this study. K.C. and E.B. conducted the literature search. K.C. and E.B. contributed to the data collection and analysis. All authors participated in the data interpretation and writing of the manuscript.

DISCLOSURE

The authors declare no conflicts of interest.

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DISCUSSION

Dr. Oscar D. Guillamondegui (Nashville, Tennessee): Dr. Chouliaras and the team at L.A. County present a six-year retrospective case report on the incidence of aero-digestive injuries in blunt force trauma to the chest and neck. By using pneumomediastinum as a marker, the group defines 258 patients out of a possible approximate 10,000 that are increased risk for injury to the proximal airway, as in the trachea and primary bronchi, or the esophagus.

This diagnostic dilemma for all of us is the high cost of missed injury versus the high cost of unnecessary workup and possible injury during that workup. In attempting to answer this question the authors diagnosed one upper airway and one esophageal injury that were directly the result of the primary trauma. There were two iatrogenic injuries also identified that were included.

The major markers discovered that increased the chance of aero-digestive injury included high ISS, low GCS, and thoracic exploration. There were really only two aero-digestive injuries and both of those were treated non-operatively. The biggest risk factor of poor outcome-the esophageal injury-was not identified on CT or chest x-ray. So, really, only one injury was picked up by the marker, pneumomediastinum.

Unfortunately, I feel that the statistical analysis suffers from a lack of outcomes. The statistical work, especially the logistic regression, actually determines the risk of pneumomediastinum and not aero-digestive injury as their initial hypothesis in the paper stated. With this in mind I have a couple of questions.

Who really needs an exhaustive workup with the triple shot (bronchoscopy, esophagoscopy, esophagram) as your title suggests? And what is the appropriate workup of those patients you suggest as the highest risk: intubated, high-injury, severity score and comatose, a group that cannot possibly undergo esophagram, the study utilized to determine 50% of your injuries?

Dr. Kimberly A. Davis (New Haven, Connecticut): I enjoyed your presentation. I have a couple of questions. Since we frequently see people with small amounts of pneumomediastinum after trauma due to the sensitivity of cross sectional imaging, I think it is vital that we identify those patients who will need evaluation. Dr. Jurkovich published a paper in 2008 which demonstrated that, in the absence of CT findings of aerodigestive tract injury, no further evaluation is required.

Do you have any insight regarding the volume of pneumomediastinum or the location of the bubbles of air that might increase your index of suspicion for an injury and should prompt further evaluation? Anything that can help us to identify at-risk patients and keep us from spending thousands of health care dollars on the multitude of patients who are unlikely to have a significant injury?

Dr. Marc A. deMoya (Boston, Massachusetts): So, we do see a fair number of these pneumomediastinum patients. And I have religiously told people not to do anything about it.

I'd like to hear more detail the injured esophagus in your one case. Was it a distal injury? Was it a cervical injury? Was there a vertebral fracture, perhaps, that penetrated the esophagus?

A little bit more about the mechanism might give us a bit more insight into how that was actually missed initially.

Dr. Michael T. White (Detroit, Michigan): As everybody has noted it is not an uncommon problem to see or to diagnose. But the numbers are so small it makes it hard for a single institution to really evaluate this. It would be nice to get kind of some "nuts and bolts" recommendations.

Have you thought about doing a multi-institutional look at this to see if you could get better numbers so you could actually come down to some conclusions that you could apply?

Dr. Paul Engels (Hamilton, Ontario, Canada): Previous work in this area that you alluded to in your presentation was performed at a Canadian institution and showed that for patients who have pneumomediastinum, if they do not have it visible on the plain chest x-ray, all those patients actually don't end up having an aero-digestive injury and don't need any further workup. I was just wondering if you could comment on the presence of pneumomediastinum on plain chest x-ray in your patient group?

The second question is in regards to the workup that you did for some of your ICU patients. As we know, some of these ICU patients are difficult to evaluate with a swallow, being intubated and ventilated, and there is an injury miss rate with esophagoscopy. Could you comment on the use of such modalities as CT-esophagrams or any other adjuncts?

Dr. Konstantinos Chouliaras (Los Angeles, California): Dear Dr. Guillamondegui and colleagues, thank you very much for your review of our manuscript and for your insightful questions and comments.

The small number of aerodigestive injuries in our study population is somewhat unexpected and perplexing. However, all patients included in this study were worked up by our ACS services and we have not missed an esophageal or tracheal injury requiring surgical or endoscopic treatment during the study period. Per previous reports in the literature, these lesions are rare following blunt trauma reaching hospital alive and our data may reflect the historical low incidence. The vast majority of mediastinal air in our study population originates from pneumothoraces as depicted in our results by 72% having a PTX and some air bubbles in the mediastinum away from aerodigestive structures requires rarely further work-up . However, we did not review the coroner data for patients receiving CT scan with suggestive of aerodigestive injuries expiring in the ED or OR.

When pneumomediastinum is located in proximity of aerodigestive structures when no PTX can explain mediastinal air coupled with hemoptysis, odynphagia, hoarsness requires an aerodigestive workup with all directed studies esophagogram, esophagoscopy and bronchoscopy. Also patients with excessive air leak through a chest tube require bronchoscopy to delineate the tracheobronchial airway injury. To answer that

question in our study we constructed a regression model to delineate independent predictors for aerodigestive injuries however due to the low incidence of primary outcomes the model provided no independent risk factors for aerodigestive injuries. However, per our findings we noted a very low incidence of aerodigestive injuries. Nevertheless, more data is required to set up management guidelines and we continue to perform exhaustive workup for obtunded patients with mediastinal air whether there is or not a PTX present. Per our protocol the obtunded patient should be worked up with an esophagoscopy and bronchoscopy that in recents studies have shown a very high sensitivity for esophageal and broncheal injuries. Per the recent data, however, the esophagogram can be omitted when an esophagoscopy is performed and normal.

Dr. Davis asked about the volume of the pneumomediastinum and its significance. This was an aspect that was considered but was not possible to be calculated in a retrospective manner. Our goal would be to design a multi-institutional study trying to measure the volume of the air in different locations in the mediastinum by using CT volumetry software to identify whether there is a specific cutoff of the volume that is correlate with aerodigestive injuries.

Dr. deMoya thank you for your question. The sole esophageal injury identified in our study was sustained by a 51-year-old male after a MVC and was missed on initial CT imaging that showed presence of gas in the retropharyngeal and possibly prevertebral space with no definite cervical fracture. The patient remained hemodynamically stable and was evaluated with a a gastrograffin swallow study during the second day of admission that was diagnostic for a proximal injury at the level of the aortic arch. On repeat swallow on the sixth day of admission there was no leak identified. This patient was discharged without any complications on the 12th day of admission with the recommendation to undergo a follow-up swallow study in six months.

Dr. White, a multicenter study would be the ideal setting for better investigation of the significance of pneumomediastinum in the identification of aerodigestive injuries after blunt trauma, granted its exceedingly low incidence.

Dr. Engles, in our study all cases with aerodigestive injuries were identified through CT imaging or other adjuncts but were missed on chest x-ray. Its low sensitivity and specificity renders it a poor diagnostic tool especially in this population of patients with a high burden of concomitant injuries. As for your next question regarding situations that preclude the use of esophagography, CT esophagography when available or endoscopy in the hands of an experienced surgeon/gastroenterologist could be a valuable resource.

I would like to thank you for the opportunity to present our research and thank you all for your valuable feedback.