Occult pneumothorax in chest trauma- to drain or not to drain?

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A real dilemma for the clinician
One morning in an Israeli hospital......
A 36-yr old patient is brought by the Mobile ICU to the Trauma Unit, after a motor vehicle accident

- List of injuries:
  * fracture of Lt femur
  * Acute abdomen (bleeding ?)
  * Lt chest trauma

- At arrival: BP 110/70, HR 128/min
- Abdominal US: rupture of spleen, some 750 ml blood in the abdominal cavity
- Chest X-ray: -three Lt ribs fractures
  - Lt chest contusion
A laparotomy is decided

- The patient gets i-v fluids
- An urinary catheter is inserted
- A decision: an abdominal CT on the way from the ED to the operating room
- The patient is accompanied on his way by a senior resident in anesthesia

The diagnosis on the abdominal CT:

Lt anterior pneumothorax

So, the question: to drain or not to drain ?!
What kind of pneumothorax (PN) is this one?

This is an

OCCULT PNEUMOTHORAX
(OPN)

This is not:

- Missed PN
- Secondary PN
- Residual PN
- Delayed PN

Definition: Occult pneumothorax (OPN) is that PN detected on CT scan or ultrasound, BUT not on (previous) a routine chest X-ray.
So, our patient has an occult pneumothorax (OPN). So what?!

Why to drain?

For the anesthesiologist, the danger of TENSION PNEUMOTHORAX during mechanical ventilation is clear.

50% of radiooccult cases of PN yield tension pneumothorax

*Tocin IM et al* Am J Roentgenol 1985;144:901
OPN has a various etiology:

- Trauma
- Bulous emphysema
- Cystic lung disease
- ARDS (a later phase)
Incidence of OPN in chest trauma
Chest trauma....

- 30% of all trauma victims
- 20-25% of all trauma deaths
- In 70% of cases- blunt trauma is the major cause of chest trauma
- 40% of all *blunt* chest trauma and 20% of all *penetrating* chest trauma develop a pneumothorax
- 5% of all trauma patients
Occult pneumothorax?! So what!!!

The detrimental effects of a PN occur when its size causes significant atelectasis and prevents full expansion of the lung.

And then.....

- Decreased lung capacity
- Anatomic shunt
- Hypoventilation
- Q/S mismatching
- Reduced cardiac output

OBSTRUCTIVE SHOCK!
Tension pneumothorax
What is your opinion?

How often is an OPN eventually diagnosed (of all PN):

* 2-3%
* 0.2-0.3%
* 12%
* 2-20%
* up to 70%
So, OPN is dangerous and not so rare.....

2-12% of all PN

And up to 72% in some series

55% in the last report of Ball et al

Most publications agree with 5%

Omar RH J Trauma Manag and Outcomes 2010;4:12

OPN is the most unrecognized diagnosis on the Chest X ray (Hehir, 1990)
Wilson H et al Injury 2009;40:928

- A retrospective study, 102 months

1881 patients, blunt trauma

307 developed PN

78% diagnosed on A-P chest x-ray

22% OPN !!!!
Why do we miss OPN on a regular (A-P) chest x ray?

- Supine x ray does not uncover small amounts of air in the pleural cavity
- Suboptimal quality of x ray
- Chest x ray is done too soon
- Chest x ray is attempting to measure a THREE-DIMENSIONAL volume of air in only two dimensions
- The amount of air which can be detected (on a supine A-P chest x ray) on cadaver: 200-400 ml
- X ray seen only seldom by a radiologist

Ball (Injury 2009;40:44)

*Incidence of OPN as high as 76% (!!!) when x-rays are interpreted by trauma team*
If this is the situation, can we improve the percentage of correct and early diagnosis of OPN?
First of all, the clinical signs

- Worsening clinical condition
  (dyspnea, cyanosis)
- Worsening blood gases values
- Presence of rib fractures
- Subcutaneous emphysema!!!! (odd ratio 5.47!!)
Although only 16% of patients with OPN had subcutaneous emphysema

98% of patients with subcutaneous emphysema had a PN, overt (82%) or occult (18%)
And what about CT scan?

CT scan picks up those OPN which are too small or too shallow to be diagnosed by a regular chest x ray.
Four years of study (1993-1997), in Roanoke, Virginia, USA

3121 trauma patients

172 PN

82 (47%) on x ray

67 (40%) on abdominal CT

14 (13%) ONLY on chest CT
This would be the first conclusion: even the abdominal CT would leave a certain percentage of OPN undiagnosed!!
And what about chest ultrasound (US)?

Lichtenstein DA et al. CCM 2005; 33:1231

Ultrasound in OPN
Three US signs were investigated:

• **Lung sliding**: pleural line visibly moves with inspiration (NORMAL !)

• **Two artifacts** (ABNORMAL):
  * A line-an horizontal line between the ribs shadows
  * B line- a vertical line which moves with the lung sliding
Ultrasound for OPN

Omar, 2010

- Does not need patient transport
- No high dose of radiation
- Sensitivity 92-100% (Crit Care Med 2005;33:1231)
- Can be easily learned and used by various members of the trauma team
- Can help positioning the chest tubes
- Pleural adhesions and emphysematous bullae could represent potential pitfalls

As per today, US evaluation of the thorax in chest trauma should be performed during the PRIMARY survey!!
Fig. 1: Diagnostic algorithm for blunt thoracic trauma. AP = anteroposterior; CT = computed tomography; eFAST = extended focused assessment with sonography for trauma.
## Lichtensteinstein results

<table>
<thead>
<tr>
<th>Ultrasound signs</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of lung sliding</td>
<td>100%</td>
<td>78%</td>
</tr>
<tr>
<td>Absent lung sliding + A line sign</td>
<td>95%</td>
<td>94%</td>
</tr>
<tr>
<td>B line</td>
<td>79%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Interesting data from 2008
(Soldati G et al. Chest 2008;133:204)

A 18-month prospective study
218 hemithoraces-109 patients

25 pneumothorax detected by CT

13 (52%) detected by A-P chest x ray
23 (92%) detected by Ultrasound (US)
(+one false positive)

In 20 out of 25 cases- a perfect agreement on the extension of the pneumothorax between CT and US
No chest x ray could give quantitative results!!
And now the crucial point!

To drain or not to drain

And to simplify the question: To drain or not to drain a patient who is supposed to be ventilated (ICU, general anesthesia)?
And this is the second question for the audience:

How many of you would drain any occult PN before mechanical ventilation?
The classical approach

Clinical and instrumental observation + O₂ administration

No deterioration

- No intervention

Deterioration?

- Simple aspiration with a catheter
- Chest tube insertion
- Thoracoscopy
But in fact we are speaking about ..........

The danger of tension PN vs Negative effects of pleural drainage
In more than 20% of drained patients a complication occurs...

- Pain
- Vascular injury
- Improper positioning of the drain
- Inadvertent tube removal
- Longer hospital stay
- Empiema
- Pneumonia

*Etoch SW et al. Arch Surg 1995;130:521*
Yes, ventilating a patient changes our behavior

(sentences picked up from literature)

• “In ventilated patients, nondrained PN progresses rapidly into tension PN”

• “Clinical opinion supports close observation as long as the patient is asymptomatic AND NOT ventilated”

• “More severe the patient, higher the indication to drain, even a small PN”
But it would be interesting to see what the literature says....
<table>
<thead>
<tr>
<th>Reference</th>
<th>Treatment</th>
<th>Outcome</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garramone, Surg Gynec Obst 1991</td>
<td>27 pts, observation</td>
<td>10 failed</td>
<td>Prophylactic chest tube BEFORE general anesthesia</td>
</tr>
<tr>
<td>Collins, Am Surg 1992;58:743</td>
<td>24 pts: 11-tube, 13-observed</td>
<td>1 intercostal injury</td>
<td>Observation safe, even with mechanical ventilation</td>
</tr>
<tr>
<td>Wolfman, AJR 1998;171:1317</td>
<td>44 pts: 20-tube, 24 observed</td>
<td>1 tension PN</td>
<td>Small PN may not require chest tube</td>
</tr>
<tr>
<td>Hill, Am Surg 1999;65:254</td>
<td>29 pts: 27 observed, 2 tube for GA</td>
<td>5 needed chest tube</td>
<td>GA and IPPV demand chest tube</td>
</tr>
<tr>
<td>Enderson, J Trauma 1993;35:726</td>
<td>40 pts: 19-tube, 21-observed</td>
<td>3 tension PN</td>
<td>Chest tube needed for mechanical ventilation</td>
</tr>
<tr>
<td>Brasel, J Trauma 1999;46:987</td>
<td>39 pts: 18-tube, 21-observed</td>
<td>No adverse effects</td>
<td>Observation is safe</td>
</tr>
</tbody>
</table>
Why the controversy?
• Different ventilatory management (IMV, pressure support, etc)
• The modern approach of limiting peak inspiratory pressure
• Time can influence, since PN volume decreases each day by:
  * 1.25% if FiO2 is 21%
  * 5-8% if FiO2 is 1
  (absorption phenomena leading to spontaneous resolution)
Nevertheless, there are some guidelines

1997, American College of Surgeons Committee of Trauma

(Ball CG et al. Can J Surg 2003;46:373)

“General anesthesia or positive pressure ventilation should NEVER BE ADMINISTERED without a chest tube being placed in any patient who has sustained a traumatic PN or is at risk for an expected PN”
And if not ?!
• The decision not to drain is to be taken with the full knowledge of the anesthesiologist in charge with the patient.

• It is compulsory to prepare the placement of a chest tube if respiratory compromise occurred.

• Long orthopedic and neurosurgical procedures might indicate a prophylactic chest insertion.

• The surgeon-anesthesiologist cooperation during the procedure is CRUCIAL for preventing disaster.
The last data
(Wilson H et al. Injury 2009, June)

- Nova Scotia Trauma Register
  1994-2003

1881 blunt chest trauma cases

307 pneumothorax cases

68 OPT

35 drained

- 29 mech. ventil
- 25 ISS
- 17 length of stay (days)
- 0 tension pneumothorax

33 not drained

- 16
- 22
- 10
- 0

Conclusion: there is no obligation to drain a OPT.
Non-draining policy may contribute to a shorter length of stay in hospital!
The good news: there are some points of consensus!
Absolute indications for chest tube insertion in case of a PN

- Expanding pneumothorax
- Respiratory compromise
- Tension pneumothorax
- Expanding subcutaneous emphysema
So, what is the stuff to take home?
• An occult PN can occur anytime, in almost any chest trauma patient

• An occult PN is small, but the danger is big

• Be prepared for the worst and try to convince that tube insertion is more benefit than cost
Fig. 1: Diagnostic algorithm for blunt thoracic trauma. AP = anteroposterior; CT = computed tomography; eFAST = extended focused assessment with sonography for trauma.
“It is better to be prepared for an opportunity and not to have one THAN to have an opportunity and not be prepared to face it”
Who said it ??

A. The American chief of civil aviation on September 10, 2001

B. A high-school teenager, before his first date

C. The chief of opposition at the municipal meeting in New Orleans

D. Lori Cross, General manager of Datex-Omeda, speaking about patient safety
Thoughtful, careful approach to occult PN can not, and shall not, be replaced by an invasive procedure as a matter of protocol, when dealing with trauma patient.
Things are not always at they seem to be