TENSION PNEUMOTHORAX AND NEEDLE DECOMPRESSION

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DISCLOSURES

✓ None
OBJECTIVES

✓ What is Tension Pneumothorax
✓ Treatment and Pitfalls
✓ New directions
OBJECTIVES

✓ What is Tension Pneumothorax
✓ Treatment and Pitfalls
✓ New directions
✔ Shortness of Breath
✔ Chest Pain
✔ Decreased A/E
✔ Low O₂ Saturation
✔ Hyper-resonance
✔ Tactile fremitus
✓ Shortness of Breath
✓ Chest Pain
✓ Decreased A/E
✓ Low $O_2$ Saturation
✓ Hyper-resonance
✓ Tactile fremitus
✓ Shortness of Breath
✓ Chest Pain
✓ Decreased A/E
✓ Low O₂ Saturation
✓ Hyper-resonance
✓ Tactile fremitus
✓ TACHYCARDIA
✓ HYPOTENSION
✓ Shortness of Breath
✓ Chest Pain
✓ Decreased A/E
✓ Low O₂ Saturation
✓ Hyper-resonance
✓ Tactile fremitus
✓ TACHYCARDIA
✓ HYPOTENSION

TENSION PTX
Pleural Air

Compresses lung
Pleural Air
\rightarrow \text{Compresses lung}
\rightarrow \text{SIMPLE PNEUMOTHORAX}
Air Increases

Collapsed lung
Air Increases

↓

Compresses Lung Even More
Air Increases
↓
Compresses Lung Even More
↓
Shifts Mediastinum
Functional Deformation + Impaired Venous Return → Decreased CO
Functional Deformation + Impaired Venous Return → TENSION PNEUMOTHORAX
- EXTRINSIC COMPRESSION
- CARDIAC DEFORMATION
- DECREASED VENOUS RETURN
OBJECTIVES

✓ What is Tension Pneumothorax
✓ Treatment and Pitfalls
✓ New directions
NEEDLE DECOMPRESSION
NEEDLE DECOMPRESSION

✓ Emergent procedure for decompression
✓ ATLS - 2nd Intercostal space, Mid-clavicular line
✓ 5 cm catheter
Retrospective, n=101
1.4% blunt patients needed
3.2-4.5 cm catheters
Assuming all had a Ptx
4-65% residual large Ptx
THE PROBLEM

CATHETER TIP
CATHETER TIP
WELL AWAY FROM PNEUMOTHORAX

CATHETER TIP
OBJECTIVES

✓ What is Tension Pneumothorax
✓ Treatment and Pitfalls
✓ New directions
DIFFERENT INSERTION SITE?

- 5th Intercostal space, anterior axillary line
- Potential benefits
  - Easily accessible supine
  - Does not impact transport
  - Experience with CT insertion
EMERGENCY TREATMENT OF TENSION PNEUMOTHORAX

LARGE BORE NEEDLE INTRODUCED INTO PLEURAL CAVITY

EXPIRATION

INCISED FINGER COT AS FLUTTER VALVE ON NEEDLE

INSPIRATION

EMERGENCY OPENING IN 2nd OR 3rd INTERSPACE AT MIDCLAVICULAR LINE WITH ANY INSTRUMENT AT HAND

NOT A NEW CONCEPT
MANIFESTATIONS OF TENSION PNEUMOTHORAX

- Cyanosis
- Marked respiratory distress
- Tracheal deviation to opposite side
- Hyperresonance
- Diagnostic tap; plunger of moistened syringe pushed out by intra-thoracic pressure
Studies

1. CADAVERIC MODEL
2. CT BASED HUMAN EVALUATION
3. EMS EVALUATION
Studies

1. CADAVERIC MODEL
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Optimal Positioning for Emergent Needle Thoracostomy: A Cadaver-Based Study

Kenji Inaba, MD, FRCSC, FACS, Bernardino C. Branco, MD, Marc Eckstein, MD, David V. Shatz, MD, Matthew J. Martin, MD, Donald J. Green, MD, Thomas T. Noguchi, MD, and Demetrios Demetriades, MD, PhD

- Human cadavers
- Traditional 2nd v. 5th ICS
- 5cm standard catheter
- 80 needles into 20 cadavers
- Clamshell to assess penetration
- Chest wall thickness measured
2\textsuperscript{nd} MID-CLAVICULAR

5\textsuperscript{th} ANTERIOR-AXILLARY
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✓ CWT 3.5 v. 4.5cm (p<0.001)
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- CWT 3.5 v. 4.5cm (p<0.001)
- 2nd ICS – 58%
- 5th ICS – 100%
SUCCESSFUL PENETRATION

![Bar chart showing successful penetration rates for right and left sides.](image)

- **Right**: 60%
- **Left**: 55%
SUCCESSFUL PENETRATION

15% for females and 70% for males.
Cadaver Summary

✓ Chest thicker at 2\textsuperscript{nd} v. 5\textsuperscript{th} ICS
✓ Especially females
✓ 42\% of 2\textsuperscript{nd} ICS did not penetrate chest
✓ 100\% at 5\textsuperscript{th} ICS successful
Cadaver Summary

- Chest thicker at 2nd v. 5th ICS
- Especially females
- 42% of 2nd ICS did not penetrate chest
- 100% at 5th ICS successful

NO cardiac, lung, hilum, aorta, spleen or liver injury...
Studies

1. CADAVERIC MODEL
2. CT BASED LIVING HUMAN EVALUATION
3. EMS EVALUATION
Evaluate 2nd v 5th using Chest CTs of real patients
Trauma >16yo undergoing Chest CT for trauma
30 random from each of 4 BMI quartiles
Aims

✓ Chest Wall thickness at each position?
✓ Could a standard 5cm needle penetrate the chest?
CHEST WALL THICKNESS

12.9 mm

13.4 mm

2nd

5th

RIGHT

LEFT

2nd ICS at MCL

5th ICS at AAL

*
FAILED CHEST ENTRY BY BMI

2nd ICS, BMI Q2
22% FAILURE
Failed Chest Entry by BMI

2nd ICS, BMI Q3
63% Failure
2nd ICS, BMI Q4
80% FAILURE
FAILED CHEST ENTRY BY BMI

5th ICS, BMI Q4
50% FAILURE
SUMMARY

- Thickness of 2\textsuperscript{nd} > 5\textsuperscript{th}
- Both R and L
- Worse as BMI increases
- At 2\textsuperscript{nd}, with eccentric placement, all but first quartile would fail
- At 5\textsuperscript{th}, decompression possible in all but last quartile
Studies

1. CADAVERIC MODEL
2. CT BASED HUMAN EVALUATION
3. EMS EVALUATION
25 EM physicians in Ireland
84% ATLS certified
Do they know where to Needle?
Can they find it on a live model?
✓ 88% named 2nd ICS MCL
✓ Only 60% able to point out where this was on patient
✓ 4% pointed out 5th ICS AAL
✓ 8% wanted to needle abdomen below & lateral to xiphoid
EMS

✓ Ability of Navy corpsmen to place 2\textsuperscript{nd} versus 5\textsuperscript{th} needles
  • Accuracy
  • Time to decompression
  • Collateral damage
EMS

- 20 Corpsmen, 80 needles
- 25.5 +/- 3.9 years, 75% male
- 4.4 +/- 3.3 years experience
- Half previous deployment
RESULTS

✓ Time to insertion
✓ Ease of localizing and inserting needle
✓ Accuracy
RESULTS

✓ Time to needle placement
  • 15.3s v 16.1s, p=0.438

✓ Ease of finding position
  • 75% rated 5\textsuperscript{th} easier, 15% the same, 10% as harder
ACCURACY

✓ Accuracy within a 10cm circle
  • 95.0% v 27.5%, p<0.001

✓ Aggregate distance from correct position
  • 1.5+/-1.6 v 3.5+/-1.6cm, p<0.001
Take Home Points

✓ Indications for needle decompression not well delineated
✓ If going to needle, know the following...
Take Home Points

✓ Standard Angiocath <5cm
✓ Chest wall 2\textsuperscript{nd} ICS >5cm in 40-50%
✓ Most in upper ¾ of BMIs cannot be decompressed with standard needle
Take Home Points

- In controlled experiments, 60% will fail entry
- R and L
- Females > Males
- Worse as BMI increases
Take Home Points

✓ May not be in chest
✓ If not responding, try again with a different angle
✓ Especially for females or obese
✓ May consider alternate positions