

# 다한증 · 흉벽기형

Hyperhidrosis & Chest Wall Deformity

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2026 흉부외과 전공의 연수교육

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# 1. Hyperhidrosis

- Diagnosis of hyperhidrosis
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- Surgical treatment
- Outcomes
- Complications
- Evidence-based approaches



# What is hyperhidrosis?

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**Excessive sweating** beyond physiologic requirement for thermoregulation

Prevalence: 1–5%

Onset: **typically before age 25**

Positive family history: 30–60%

Equal gender distribution

Significant quality-of-life impairment

Palmar (60–70%), axillary (30–40%), plantar (60–70%), craniofacial (10%)

**Subjective  
Impairment in daily activities**

# Pathophysiology

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Hyperactivity of sympathetic pathways

Cholinergic stimulation of eccrine glands

Mixture of apocrine and eccrine glands in axillary hyperhidrosis

No increase in gland number

Genetic component

Important concept

***"The problem is neural regulation, not gland pathology"***

# Pathophysiology

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2-4million sweat glands

Apocrine, eccrine, apoeccrine glands

**Thermoregulation modulated by sympathetic nervous system with higher control from cerebral cortex and anterior hypothalamus**

Sweat: hypotonic to plasma (ductal resorption of electrolytes)

Neurogenic over-activity or hyper-excitability of reflex circuits stimulating eccrine glands

| Types of hyperhidrosis  | Commonly associated diseases and conditions                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Primary hyperhidrosis   | Idiopathic (focal) hyperhidrosis<br>Gustatory hyperhidrosis (Frey's syndrome)                                                                                                                                                                                                                                                                                                                                               |
| Secondary hyperhidrosis | Endocrine: hyperthyroidism, hyperpituitarism, diabetes mellitus, menopause, pregnancy, pheochromocytoma, carcinoid syndrome, and acromegaly<br>Neurological: Parkinson's disease, spinal cord injury, and stroke<br>Neoplastic: Hodgkin's disease and myeloproliferative diseases<br>Infectious: tuberculosis and septicemia<br>Drugs: fluoxetine, venlafaxine, doxepin<br>Toxicity: alcoholism and illicit substance abuse |

**Focal or Primary HH – Craniofacial, palmar, axillary, or plantar**

# Diagnostic criteria Hornberger (2004)

- Visible focal sweating

> 6 months

- Without apparent cause

- Plus  $\geq 2$  of:

- Bilateral and symmetric
- Impairs daily activities
- $\geq 1$  episode/week
- Onset before <25
- Family history
- Stops during sleep

# Hyperhidrosis Disease Severity Scale (HDSS)

- Self-reported focused on daily function

| HDSS Score | How would you rate your severity of sweating (daily activities) | Severity    |
|------------|-----------------------------------------------------------------|-------------|
| 1          | Never noticeable, never interferes                              | Mild        |
| 2          | Tolerable, sometimes interferes                                 | Moderate    |
| 3          | Barely tolerable, frequently interferes                         | Severe      |
| 4          | Intolerable, always interferes                                  | Intolerable |

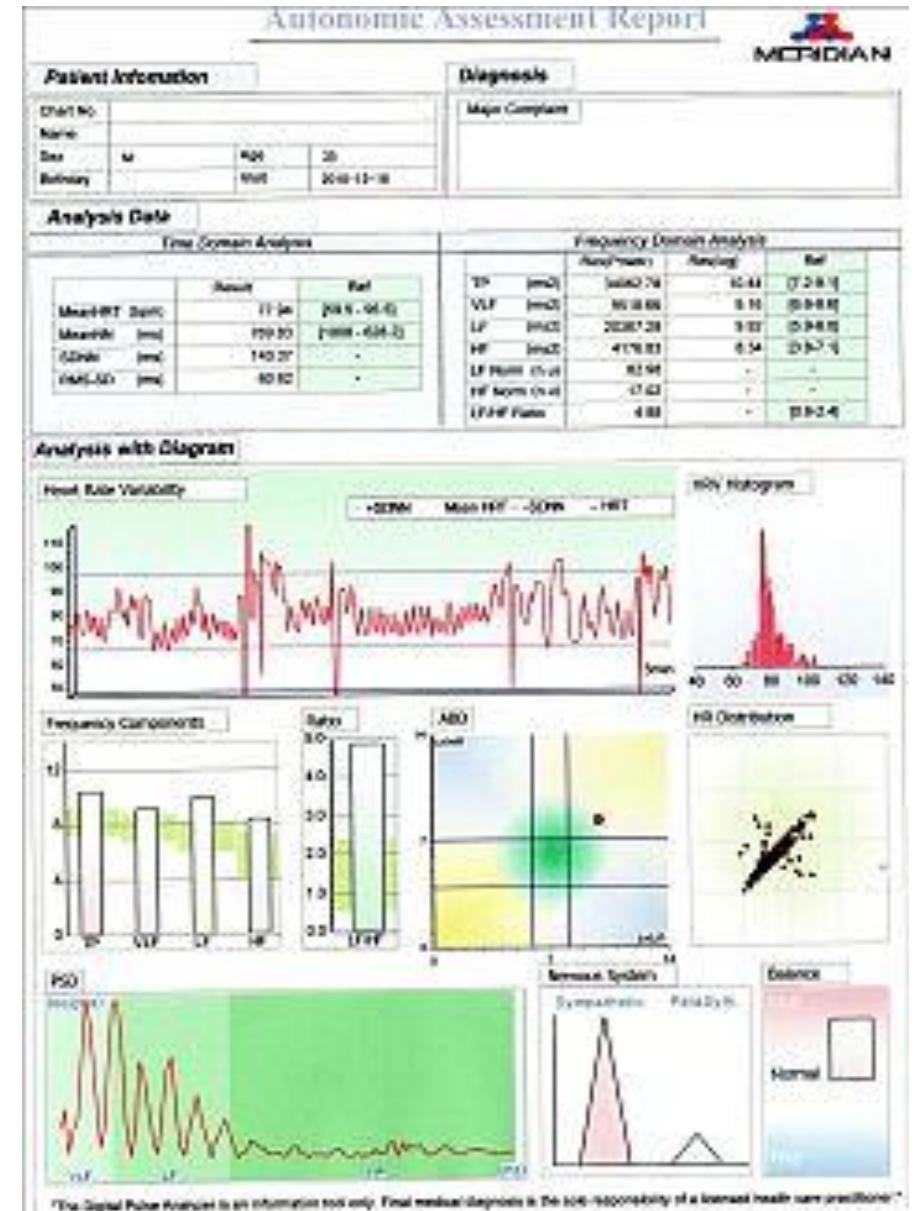
# Diagnostic tests

- Minor's Starch Iodine Test
- Iodine application, starch powder
- Dark blue discoloration



# HRV test

- Evaluate autonomic dysfunction
- Sweat glands are directly innervated by sympathetic nerve fibers



# HRV test

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High **low-frequency to high-frequency ratio** (LF/HF) = generalized sympathetic nervous system dominance

Flatter cardiac variation and overactive sudomotor (sweat) pathways

**Parasympathetic blunting**

# HRV test

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Craniofacial hyperhidrosis: **highest level of sympathetic dominance** and restricted HRV range

Palmar/ Plantar hyperhidrosis: higher total HRV metrics (SDNN, RMSSD) -> **localized hyper-responsiveness** of peripheral nerve terminals than complete systemic overload

# Nonsurgical managements

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**1st line: topical therapy**

**2nd line: iontophoresis, oral medications**

**Third line: botox**

**Fourth line: surgery**

Table 2. Comparison of Therapies for Primary Hyperhidrosis

| Treatment                                                                        | Cost <sup>a</sup> | Side Effects                                                                                                                                                                                                                                         |
|----------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topical, 20% to 35% aluminum chloride                                            | \$288+/year       | Skin irritation, localized burning, stinging, desquamation, poor efficacy, temporary (lasts about 48 hours per application)                                                                                                                          |
| Iontophoresis (usually 20 mA 3 to 4 treatments a week for 30 to 40 minutes each) | \$500/device      | Irritation, dryness or peeling of skin, burning or stinging during therapy, temporary (one treatment lasts 1 to 4 weeks). Not recommended for women who are pregnant or for persons with pacemakers or substantial implants (eg, joint replacements) |
| Oral therapy (glycopyrrolate, atropine, acetylcholine inhibitors)                | \$240+/year       | Dry mouth, dry eyes, constipation, mydriasis, difficulty urinating, blurry vision                                                                                                                                                                    |
| Botulinum toxin (Botox A or B)                                                   | \$2,250/session   | Pain from injections, muscle weakness, headache, hematoma, swelling, need for repeat procedures                                                                                                                                                      |
| Liposuction/VASER                                                                | \$3,000/session   | Hematoma, superficial skin erosion, alopecia, paresthesia                                                                                                                                                                                            |
| Endoscopic thoracic sympathectomy                                                | \$15,000          | Compensatory hyperhidrosis, bradycardia, pneumothorax, postoperative pain, Horner's syndrome                                                                                                                                                         |

<sup>a</sup> Approximate cost in US dollars.

+ Endoscopic Lumbar Sympathectomy (ELS)

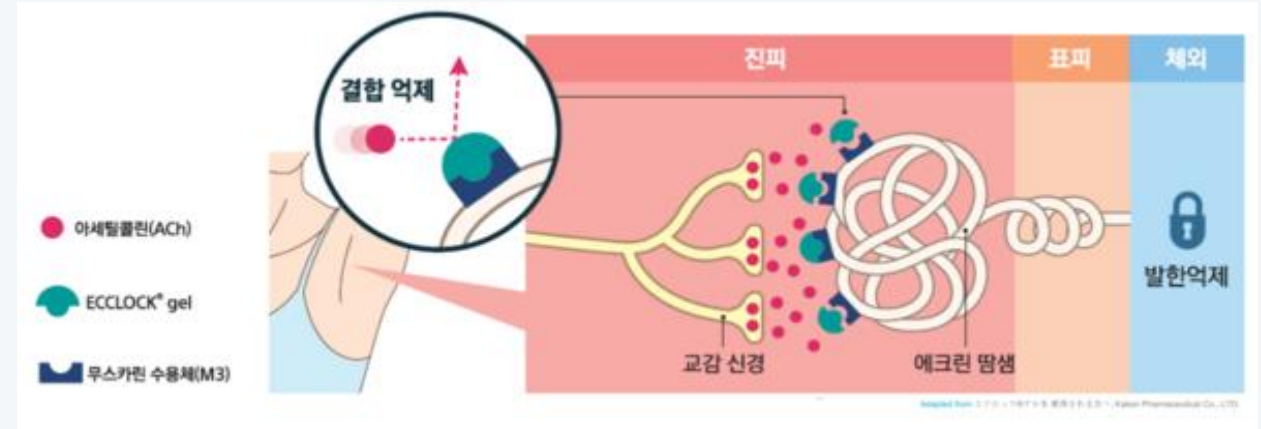
# Aluminium chloride hexahydrate

- Obstructs eccrine sweat duct
  - Causes functional and structural gland inhibition
  - Apply at night, wash off in the morning
- 
- Cheap easy
  - Skin irritation
  - Limited efficacy in severe, generalized disease
- 
- Ex) 노스엣, 드디클로, 스웨클로, 드라이언, 데오클렌



# Sofpironium Bromide

- Topical anticholinergics
- Muscarinic receptor inhibition
- Region-specific FDA approval
- Ex) 에크락겔 5%



국내 최초 전문의약품\*

원발성 거드랑이 다한증 치료제

## 에크락® 겔 5%

(소프피로니움브롬화물)

영상 보러가기

# Topical glycopyrronium (glycopyrrolate)

- Muscarinic receptor blockade
- Reduced cholinergic stimulation of eccrine glands
- Mydriasis (eye exposure)
- Local erythema
- Ex) 스웨트롤



# Iontophoresis

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FDA approved 1st line safe effective treatment for palmar and plantar hyperhidrosis

Passage of galvanic electrical current through skin submerged in water.

Hydrogen ions accumulate, causing a temporary blockage of the eccrine duct at the level of the stratum corneum

# Botulinum toxin

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**inhibits release of ACh at sympathetic nerve terminals innervating eccrine sweat glands, reducing sweat production**

**FDA-approved for the treatment of axillary hyperhidrosis only**

# PO Medications for Hyperhidrosis

| Feature                          | Oxybutynin         | Glycopyrrolate                        |
|----------------------------------|--------------------|---------------------------------------|
| Drug class                       | Antimuscarinic     | Antimuscarinic                        |
| FDA indication                   | Overactive bladder | Reduction of secretions, GI disorders |
| Hyperhidrosis use                | Off-label          | Off-label                             |
| Blood-brain barrier penetration  | Significant        | Minimal                               |
| CNS adverse effects              | More common        | Less common                           |
| Typical starting dose            | 2.5 mg daily       | 1 mg daily                            |
| Typical maintenance dose         | 5–15 mg/day        | 2–8 mg/day                            |
| Evidence base                    | Stronger           | Moderate                              |
| Elderly patients                 | Less favorable     | More favorable                        |
| Preferred by many dermatologists | Yes                | Yes, when CNS effects are a concern   |

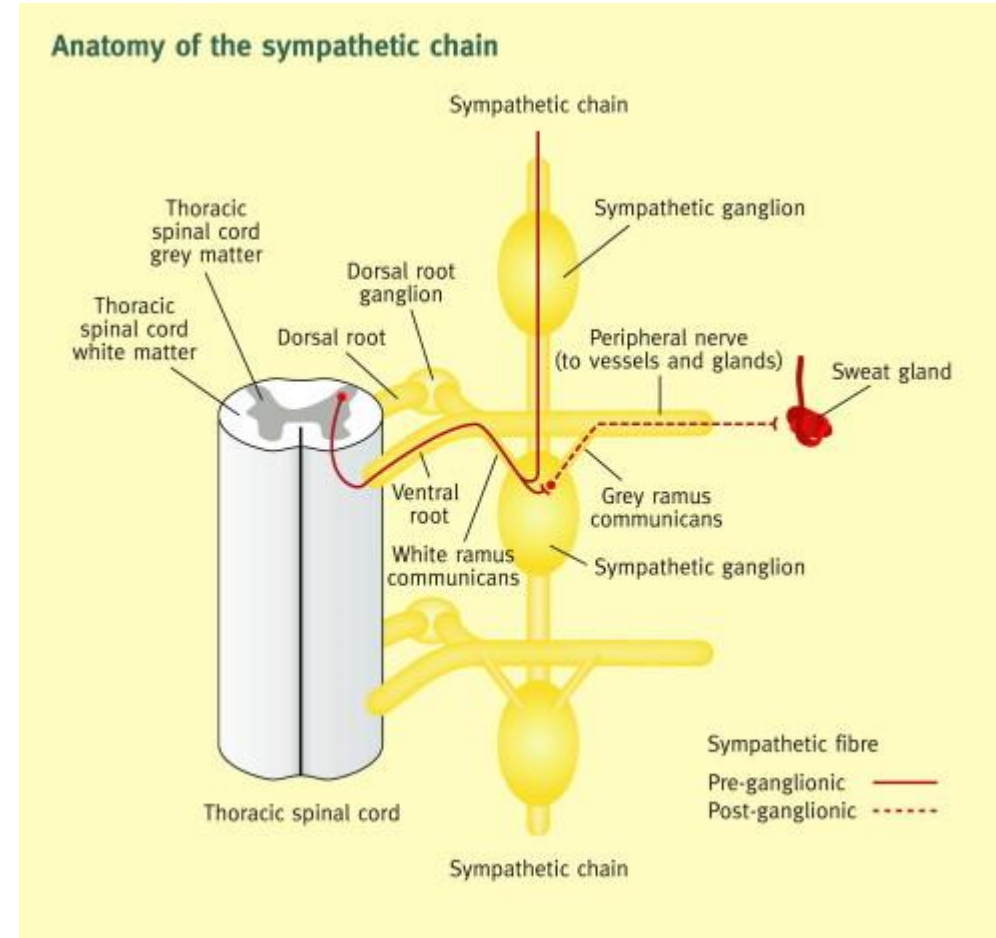
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| Outcome             | Medication                         |
|---------------------|------------------------------------|
| Evidence base       | Oxybutynin                         |
| Cost                | Oxybutynin                         |
| CNS tolerability    | Glycopyrrolate                     |
| Elderly patients    | Glycopyrrolate                     |
| Overall efficacy    | Similar; oxybutynin>glycopyrrolate |
| Long-term adherence | Slight advantage glycopyrrolate    |

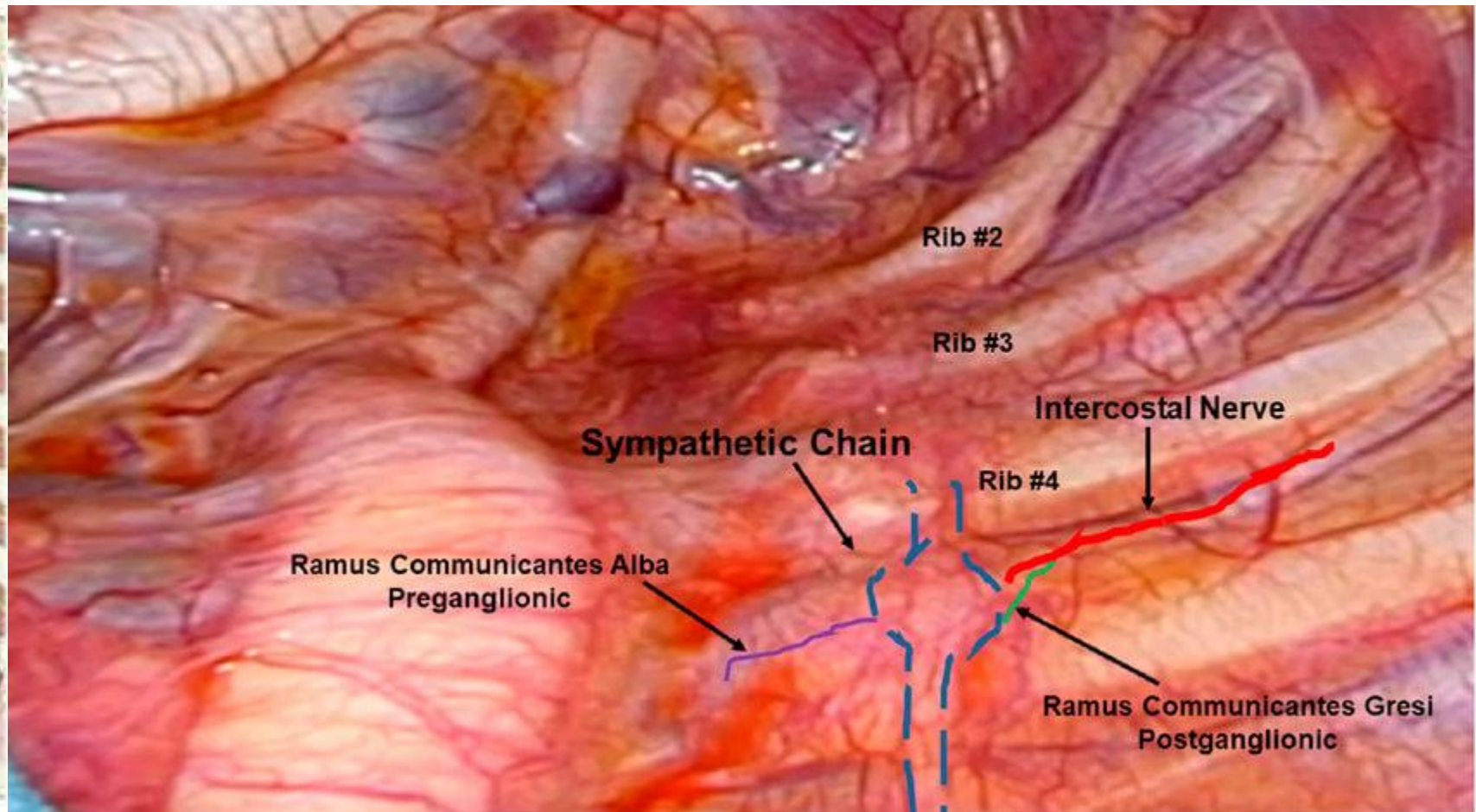
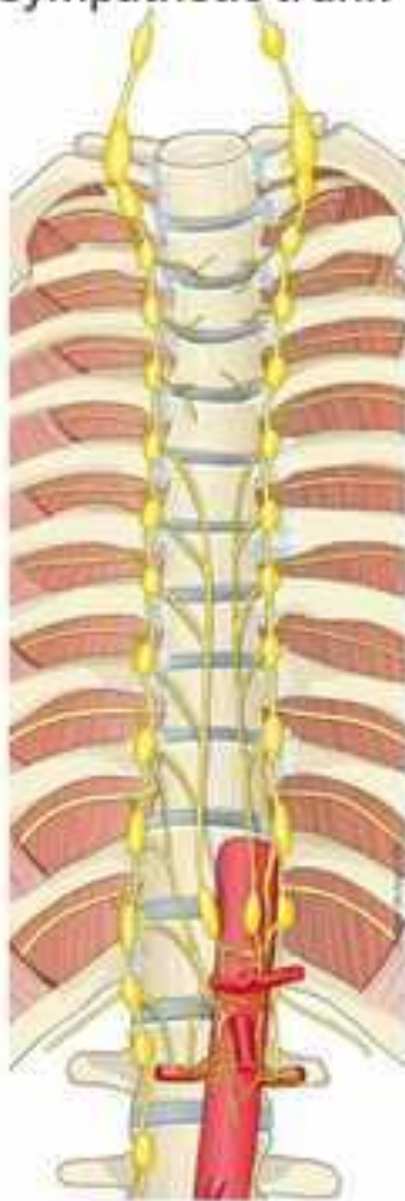
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# Anatomy of Sympathetic Chains

- Thoraco-lumbar portion of sympathetic chains → nerve fibers to sweat glands
- Central ganglia of sympathetic chain forms two vertical rows on either side of vertebral column
- Each ganglion had neural connection to adjacent ganglia
- 12 ganglia in the thorax
- 2-3mm thick, overlying parietal pleura

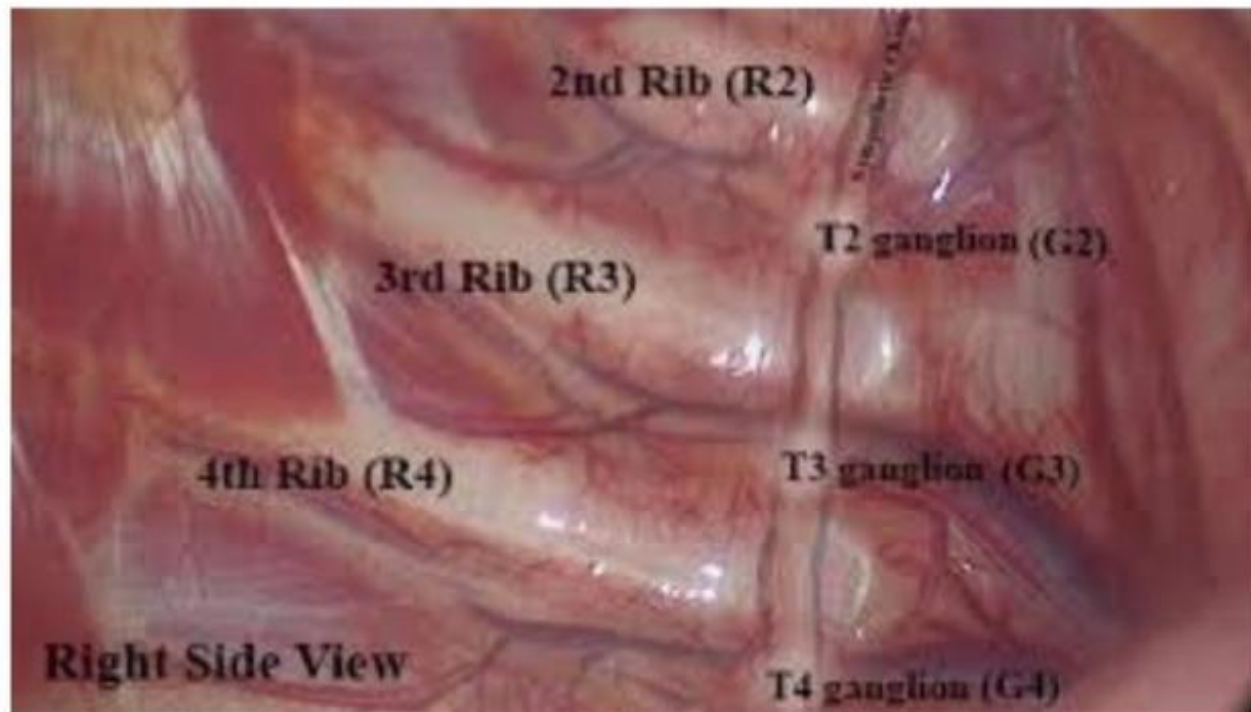


Sympathetic trunk



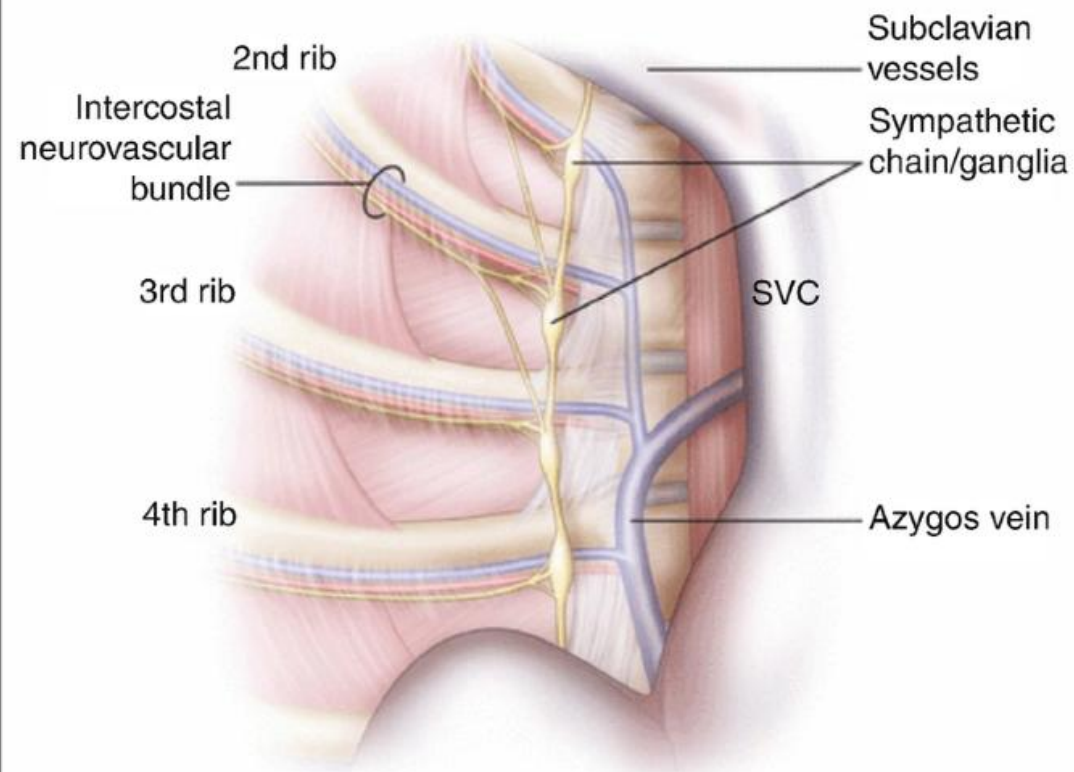
# Rib oriented nomenclature (STS)

| Rib | Location                 |
|-----|--------------------------|
| R2  | Over 2 <sup>nd</sup> rib |
| R3  | Over third rib           |
| R4  | Over fourth rib          |
| R5  | Over fifth rib           |



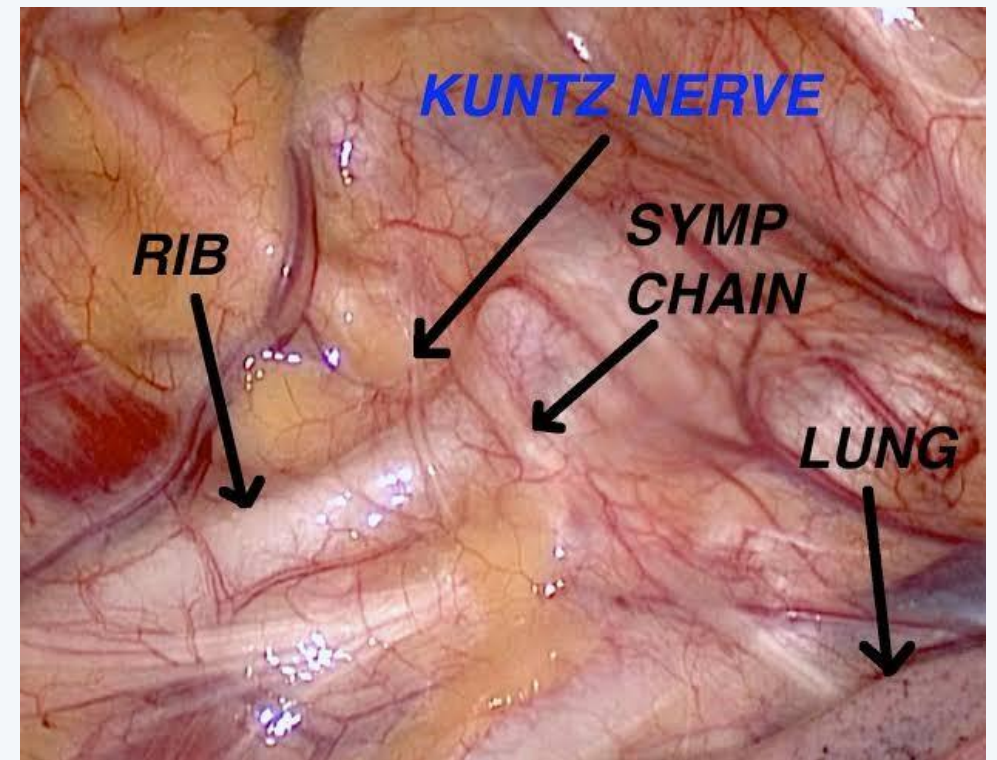
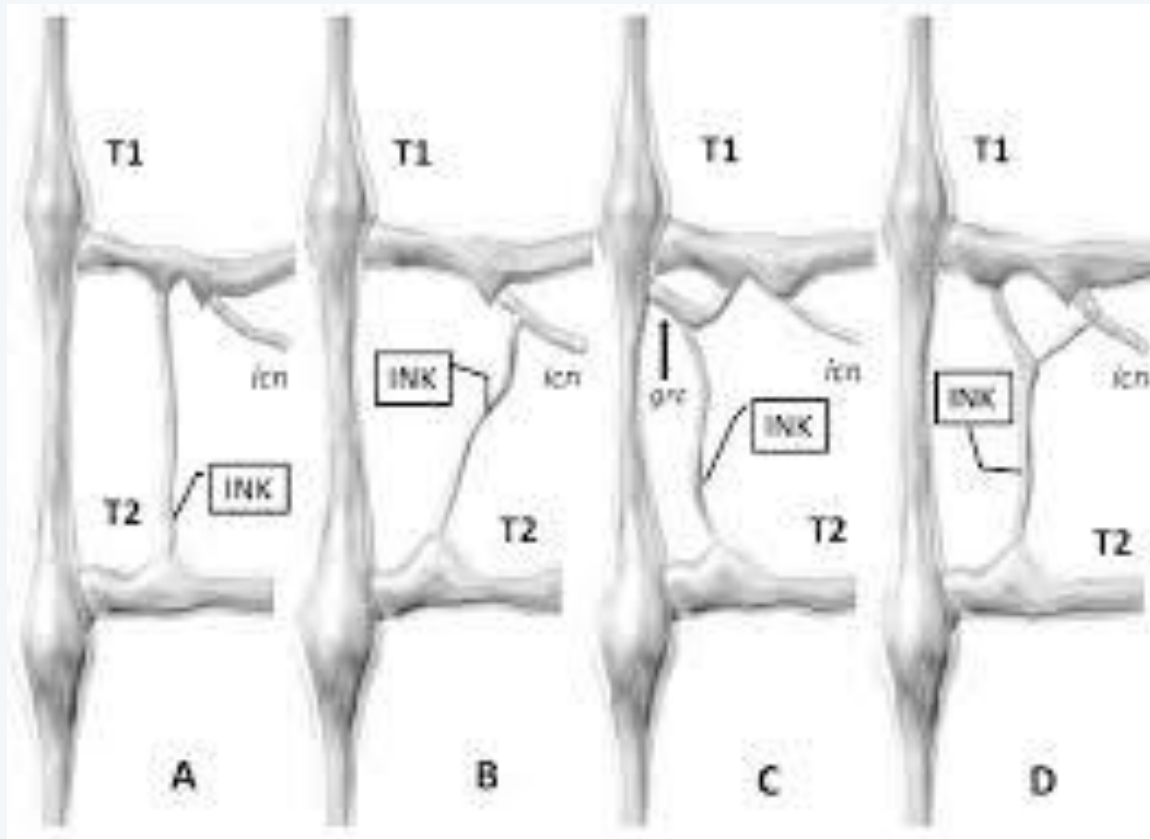
**CAMERA IMAGE**

## ILLUSTRATION



- **Kuntz Nerve**

- Accessory sympathetic fibers
- 20-60% incidence
- Incomplete interruption may cause recurrence



# Thoracic ganglia

| Level | Relevance        |
|-------|------------------|
| T2    | Palmar           |
| T3    | Palmar           |
| T4    | Axillary         |
| T5    | Adjunctive level |

# Surgical Treatment

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1920s: first open surgical thoracic sympathectomy

1930s: dorsal and supraclavicular approaches

2000s: minimal invasive, endoscopic surgeries

**Thoracoscopic sympathectomy**

| Technique      | Mechanism                  | Advantages              | Disadvantages                          |
|----------------|----------------------------|-------------------------|----------------------------------------|
| Sympathectomy  | Resection of chain/ganglia | Durable interruption    | More extensive denervation             |
| Sympathicotomy | Division over rib level    | Most common ETS         | Recurrence if accessory fibers persist |
| Ganglionectomy | Removal of ganglion        | Precise target          | Technically more demanding             |
| Clipping       | Mechanical interruption    | Potential reversibility | Variable reversal                      |

# How to...

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Transection?

No clear differences (but clipping shows recurrence)

Resection?

If the correct level division was achieved

Ablation with a cautery?

Enough separation between the ends of the chain

Division with a harmonic scalpel?

Regrowth is impossible

Clipping?

# ETS Interruption Level

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Palmar HH: R4 only

- Limits the degree of CH
- May lead to moister hands

Axillary HH: R4, 5

- Completely dry hands
- Higher risk of CH

CFH: R2 vs. R3

 **Key Level – R4 in ETS**

# VATS technique

- General anesthesia
- Single lumen + CO2 insufflation
- Double lumen
- Arms outstretched on arm boards
- Reverse Trendelenberg position
- 3mm scope
- 3mm ports



# Summary of Outcomes

| Outcome               | R2       | R3        | R4        |
|-----------------------|----------|-----------|-----------|
| Palmar Dryness        | Highest  | Excellent | Excellent |
| Compensatory Sweating | Highest  | Moderate  | Lowest    |
| Satisfaction          | Moderate | High      | High      |

# Complications

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Incomplete sympathectomy leading to recurrence and failure

Bleeding

**Pneumothorax**

Horner's syndrome

**Compensatory hyperhidrosis**

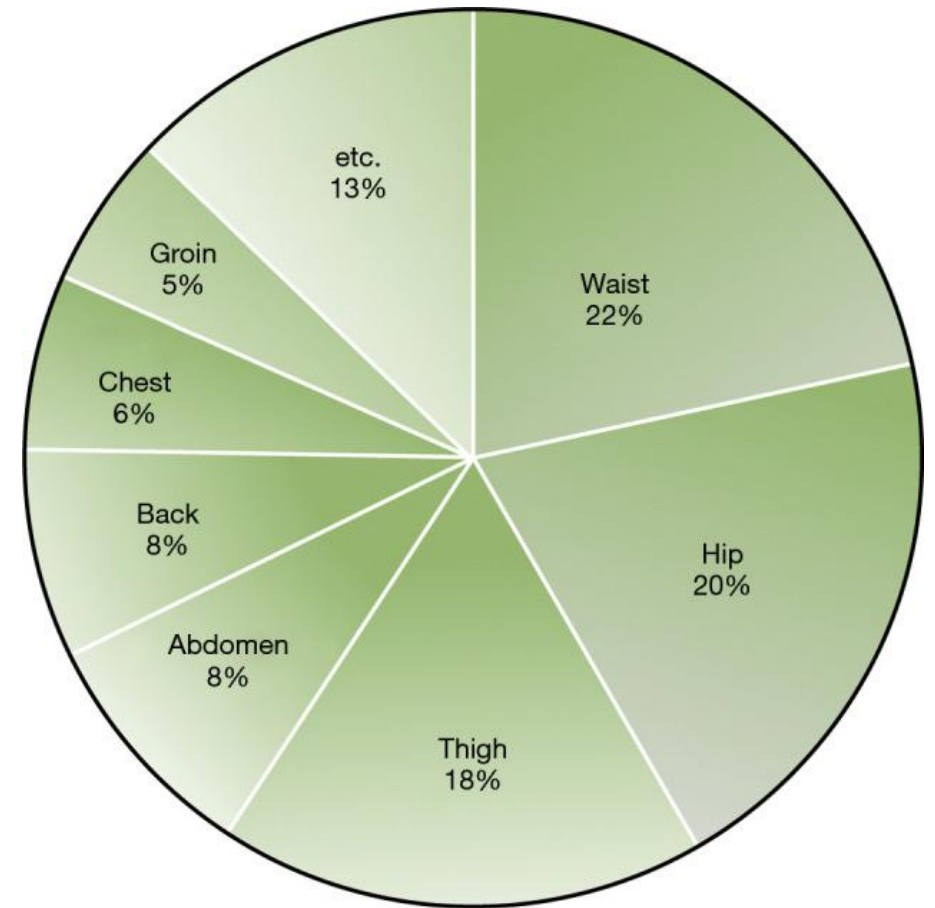
Brachial plexus injury

Cardiac arrhythmia, bradycardia

**Vasovagal syncope**

# Compensatory Sweating

- Most important complication
- Occurs in literature from 3% to 98%
- Back, abdomen, thighs
- Could be worse than original symptoms
- Major determinant of patient satisfaction
- Reflex hypothalamic responses
- Biophysical requirement for evaporative heat balance due to reduced effective BSA



Moon DH, Kang DY, Lee HS, Lee JW, Lee YJ, Lee S. To avoid compensatory hyperhidrosis after sympathetic surgery for craniofacial hyperhidrosis. J Thorac Dis. 2020 May;12(5):2529-2535.

- The most common risk factor

- **T2 ganglion interruption (R2, R3)**

- The number of levels interrupted has been inconclusive as a risk factor

- Preoperative testing? Controversial

- Injecting bupivacaine

- Reversibly achieve sympathetic nerve blockade observe for CH

- Treatment:

- **Ditropan** or other anticholinergic medications in escalating doses

## To avoid compensatory hyperhidrosis after sympathetic surgery for craniofacial hyperhidrosis

[Duk Hwan Moon](#)<sup>1</sup>, [Du-Young Kang](#)<sup>2</sup>, [Hye Sun Lee](#)<sup>3</sup>, [Ji-Won Lee](#)<sup>4</sup>, [Yong-Jae Lee](#)<sup>4</sup>, [Sungsoo Lee](#)<sup>1,✉</sup>

► Author information ► Article notes ► Copyright and License information

PMCID: PMC7330312 PMID: [32642160](#)

### Abstract

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#### Background

Endoscopic thoracic sympathectomy (ETS) has not been widely adopted for treating craniofacial hyperhidrosis (CFH) due to its known postoperative complication, compensatory hyperhidrosis (CH). In this study, we evaluated whether the autonomic nerve analysis data via pre-ETS heart rate variability (HRV) test can predict post-ETS CH in patients with CFH.

#### Methods

From October 2017 to March 2019, we consecutively included CFH patients who underwent

► Surg Endosc. 2022 May 9;36(11):8340–8348. doi: [10.1007/s00464-022-09284-w](https://doi.org/10.1007/s00464-022-09284-w) 

## Patient experience and prognostic factors of compensatory hyperhidrosis and recurrence after endoscopic thoracic sympathicotomy

[Wongi Woo](#)<sup>1</sup>, [Bong Jun Kim](#)<sup>1</sup>, [Du-Young Kang](#)<sup>2</sup>, [Jongeun Won](#)<sup>1</sup>, [Duk Hwan Moon](#)<sup>1</sup>, [Sungsoo Lee](#)<sup>1,✉</sup>

► Author information ► Article notes ► Copyright and License information

PMCID: PMC9083484 PMID: [35534737](#)

### Abstract

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#### Objective

We aimed to investigate compensatory hyperhidrosis (CH) and recurrence based on an online survey of patients who underwent endoscopic thoracic sympathicotomy(ETS) for palmar and/or axillary hyperhidrosis.

#### Methods

# Risk Factors of Recurrence and CH

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**Younger age:** indication of better outcome in terms of symptom improvement and reduced risk of CH development

**Antiadhesive agents:** adhesive tissues and fibrosis could assist the sympathetic neural tissues in recovering their electric conductions ( $P < 0.001$ , OR 0.42)



Thieme



► Thorac Cardiovasc Surg. 2025 Sep 28;74(1):75–79. doi: [10.1055/a-2699-8163](https://doi.org/10.1055/a-2699-8163)

## Unilateral versus Bilateral T3 Ganglionectomy in Primary Palmar Hyperhidrosis Patients

[Beatrice Chia-Hui Shih](#)<sup>1,✉</sup>, [Duk Hwam Moon](#)<sup>1</sup>, [Sungsoo Lee](#)<sup>1</sup>

► Author information ► Article notes ► Copyright and License information

PMCID: PMC12747789 PMID: [40935159](https://pubmed.ncbi.nlm.nih.gov/40935159/)

### Abstract

#### Background

Primary palmar hyperhidrosis (PPH) causes excessive hand sweating, impacting daily activities and quality of life. Endoscopic thoracic sympathectomy (ETS), including ganglionectomy, is a common treatment, but the risk of compensatory hyperhidrosis (CH) remains a concern. This study compares unilateral versus bilateral T3 ganglionectomy, focusing on differences in CH occurrence and patient satisfaction.

#### Methods

We retrospectively analyzed 118 patients who underwent either unilateral or bilateral T3 ganglionectomy for PPH at our institution from November 2023 to January 2025. Data on

## Postoperative Outcomes

Unilateral vs. bilateral sympathetic surgery

PATIENT SATISFACTION · “Very satisfied”

$p < 0.001$



COMPENSATORY HYPERHIDROSIS (CH)

UNILATERAL · No CH

80%

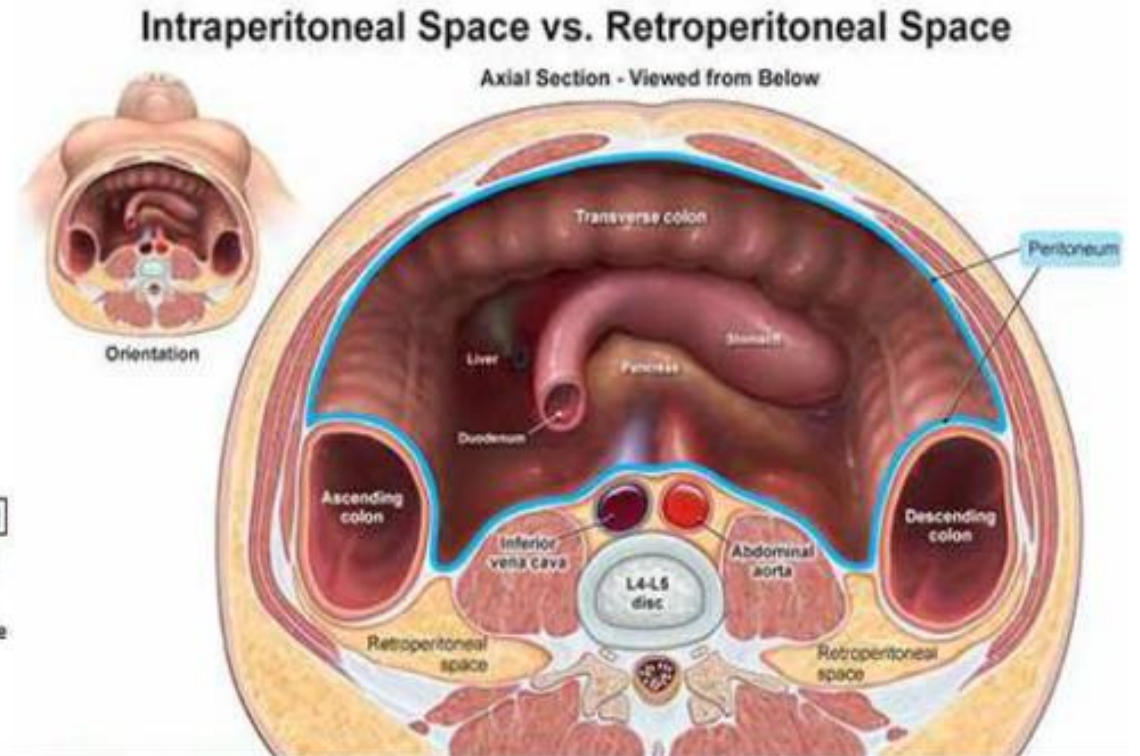
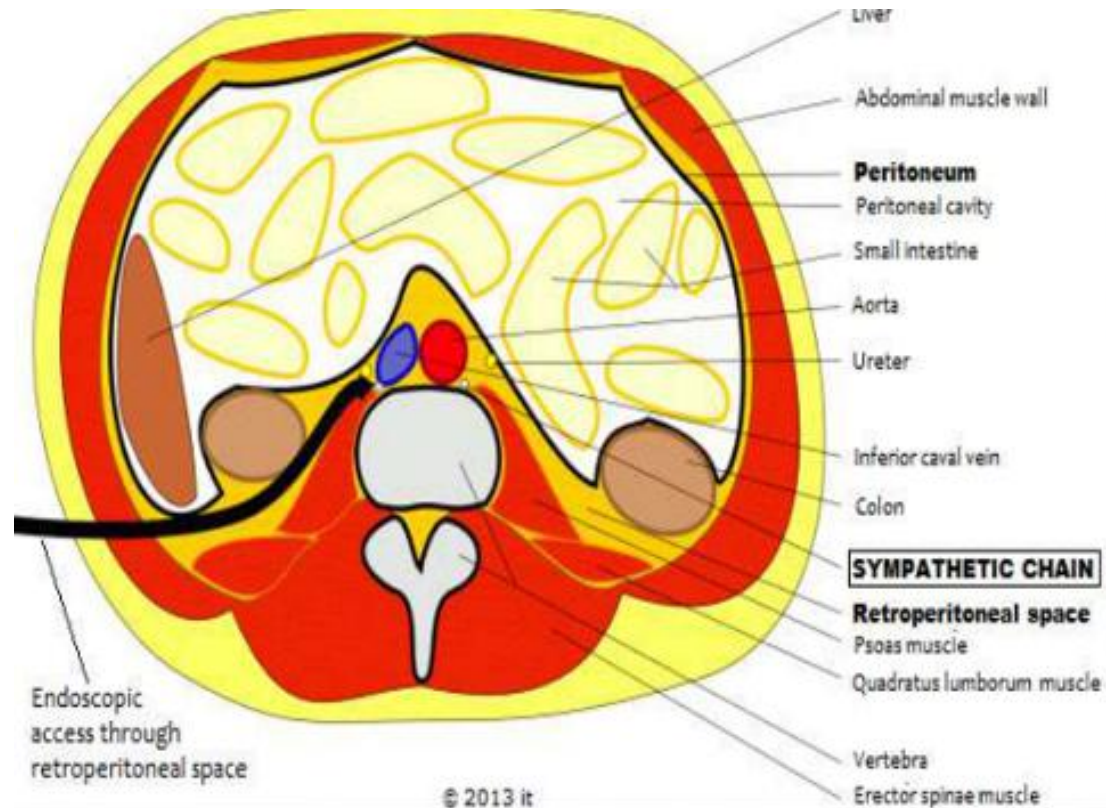
BILATERAL · Mild CH

43%

$p = 0.007$

Postoperative satisfaction was higher in the unilateral group, with 93% reporting being “very satisfied” compared with 61% in the bilateral group ( $p < 0.001$ ). The unilateral group also had fewer incidences of CH, with **80% reporting no CH**, while 43% of the bilateral group experienced mild CH ( $p = 0.007$ ).

# Endoscopic Lumbar Sympathectomy





# **Chest Wall Deformity – Pectus Excavatum**

Funnel chest is an oval depression which involves the sternum as well as the costal cartilages.

# Chest Wall Deformity – Pectus Excavatum

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Usually it is already evident in infancy and it becomes more marked as the child reaches maturity.

The degree of the deformity varies from a mild depression on the sterno-xiphoid angle, to a severe “cave in” of most of the anterior chest wall with the lower sternum touching the vertebral column.

- Pectus excavatum is a relatively common anomaly
  - Occurs in about 300-400 live births
  - Three times more frequent in males
  - Often associated with connective tissue disorders, such as Marfan's disease or Ehlers-Danlos syndrome
- Symptoms:
  - Palpitation, exertional dyspnea, fatigue and dull precordial pain, paradoxical breathing, exercise intolerance
- The deformity is also often emotionally disturbing, especially in adolescents who often avoid active sports and become shy and retiring.

- Heredity: about 20-50% of patients have a family history of pectus deformities – Williams 1872
- An overgrowth of the costal cartilages – Lincoln Brown 1939 (1596)
- Arrested growth of the sternum –Ebstein 1882
- Various intrauterine compressive forces such as pressure by the chin, knee or elbow
- Latent mediastinitis –Rausbitsch
- Undue traction exerted upon the sternum by the diaphragmatico-sternal ligament – Lincoln Brown 1939 (1596)

# Chest Wall Deformity – Haller Index

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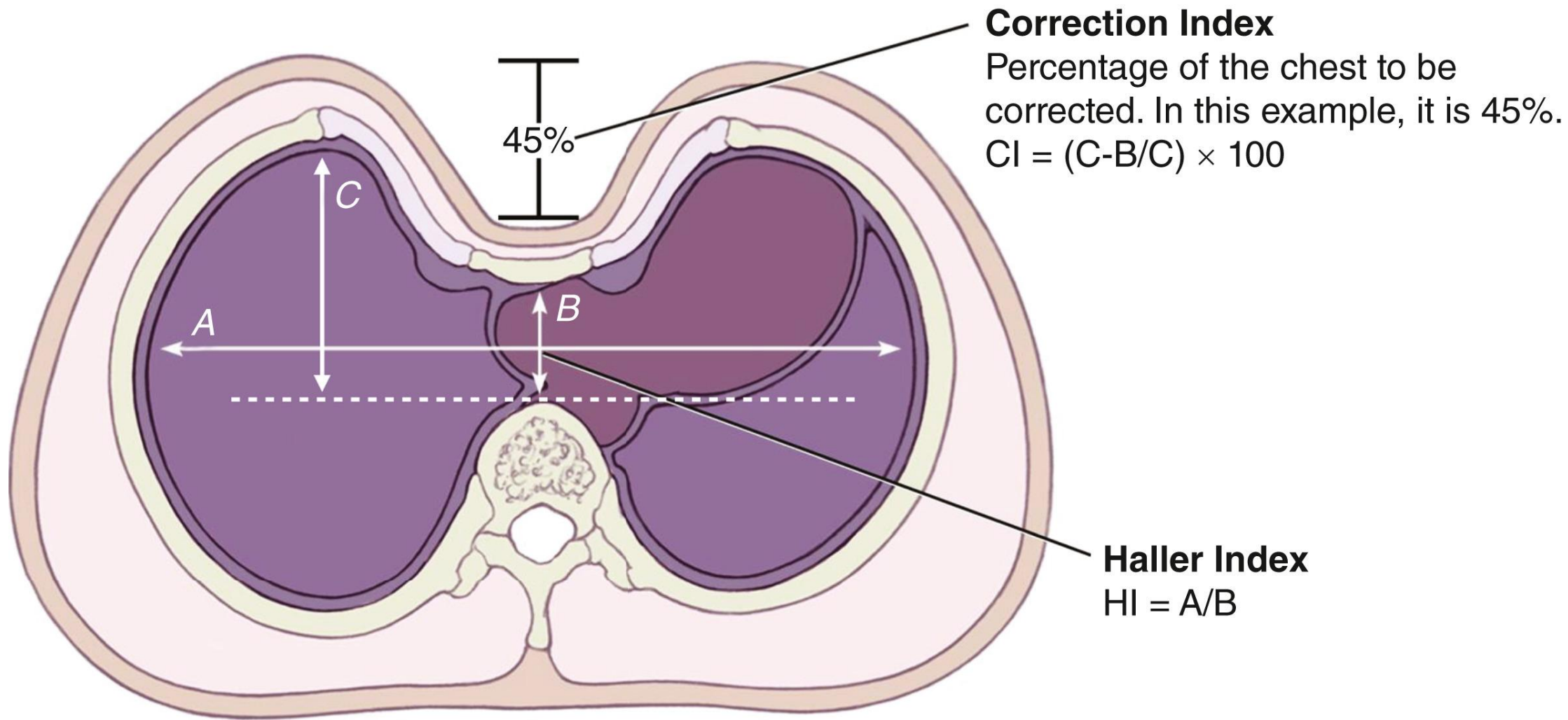
Pectus Severity Index

Used to assess severity of incursion of the sternum into the mediastinum

**Maximal transverse diameter/narrowest AP length of chest**

Normal HI = 2.5

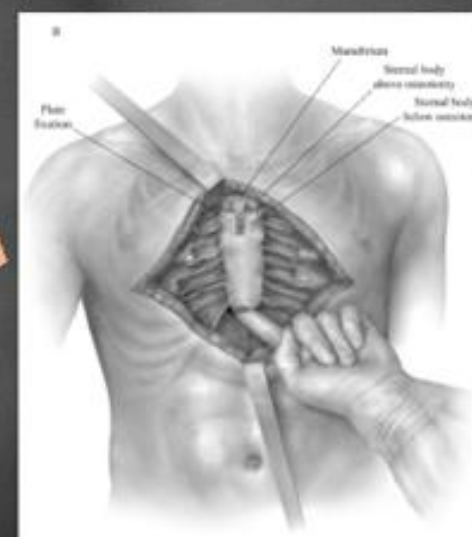
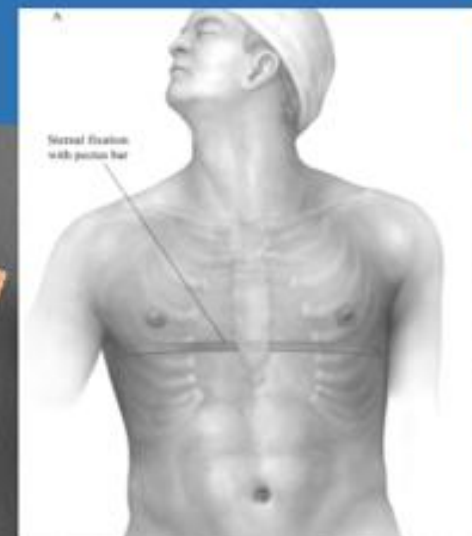
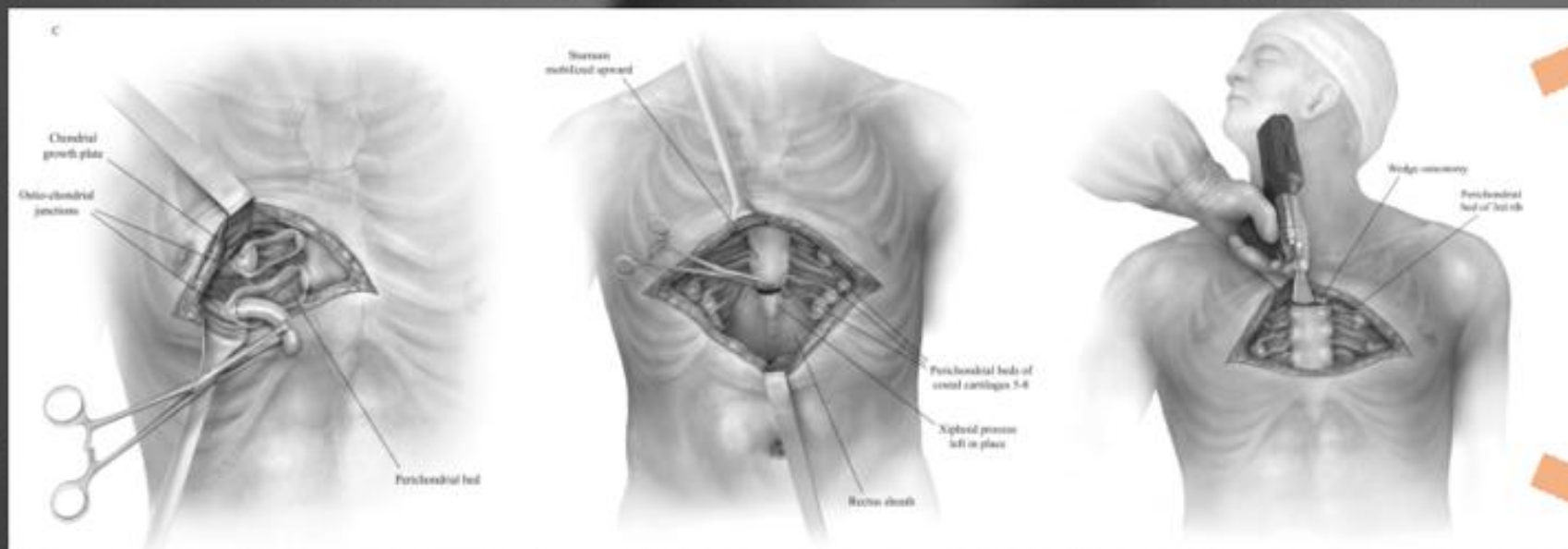
Significant PE has HI  $>3.25$  -> standard for determining candidacy for repair

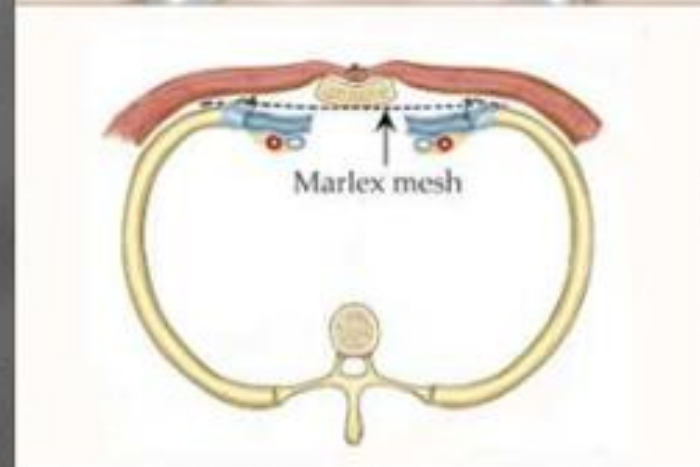
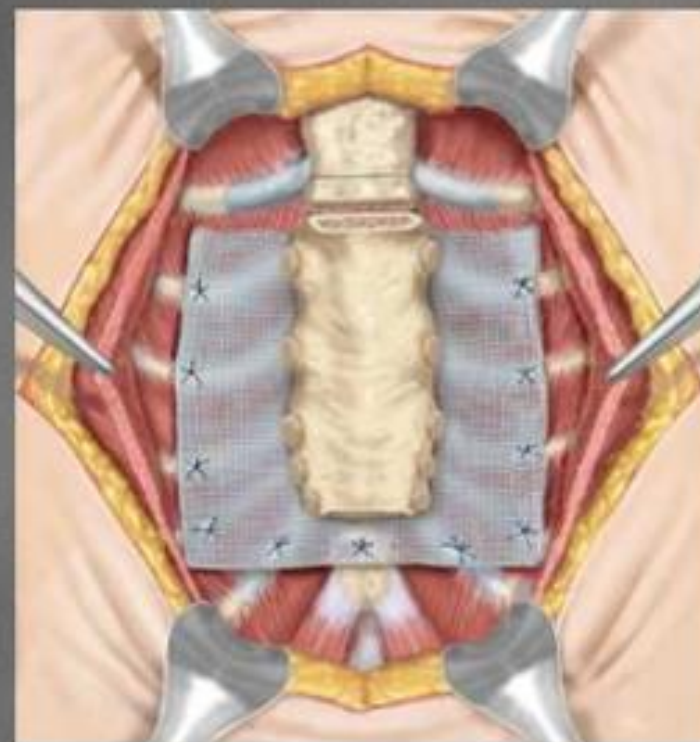
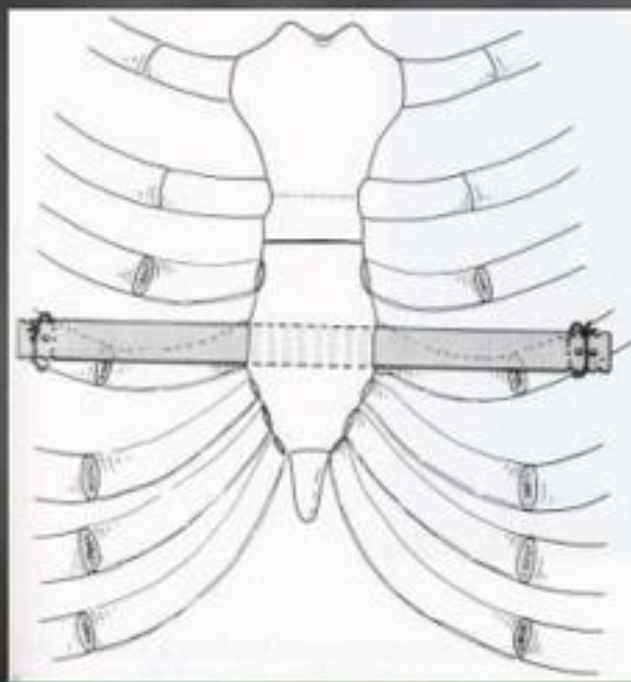
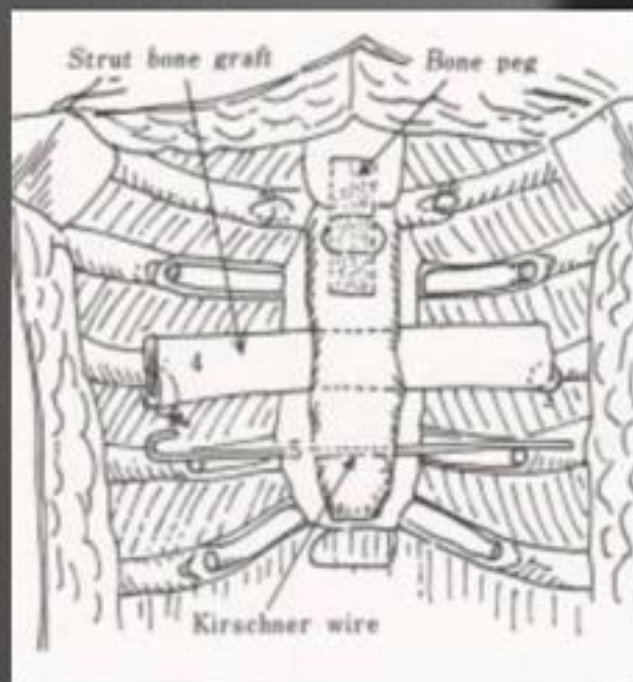


# History of Surgery for Pectus Excavatum

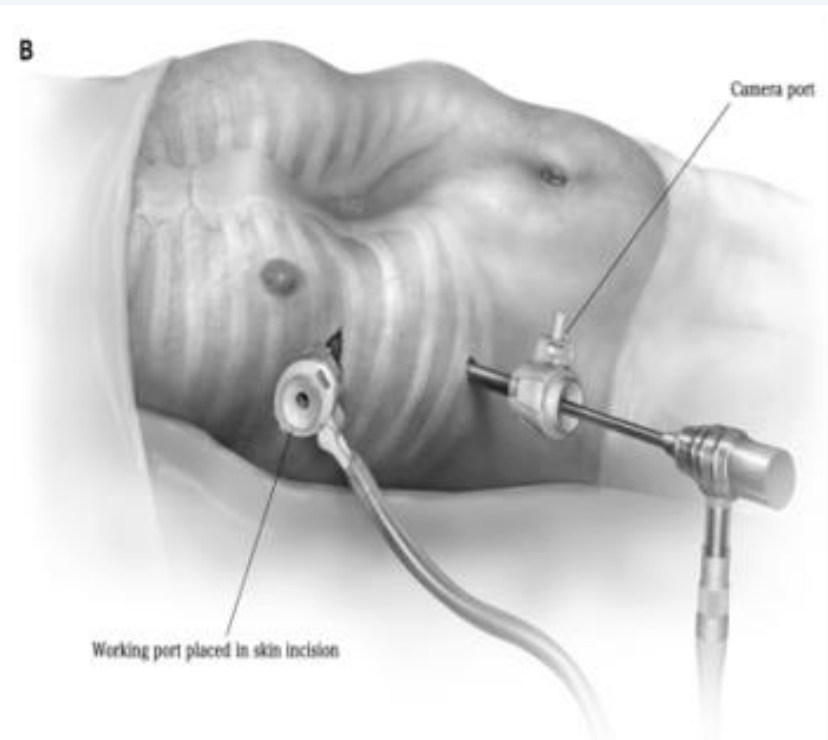
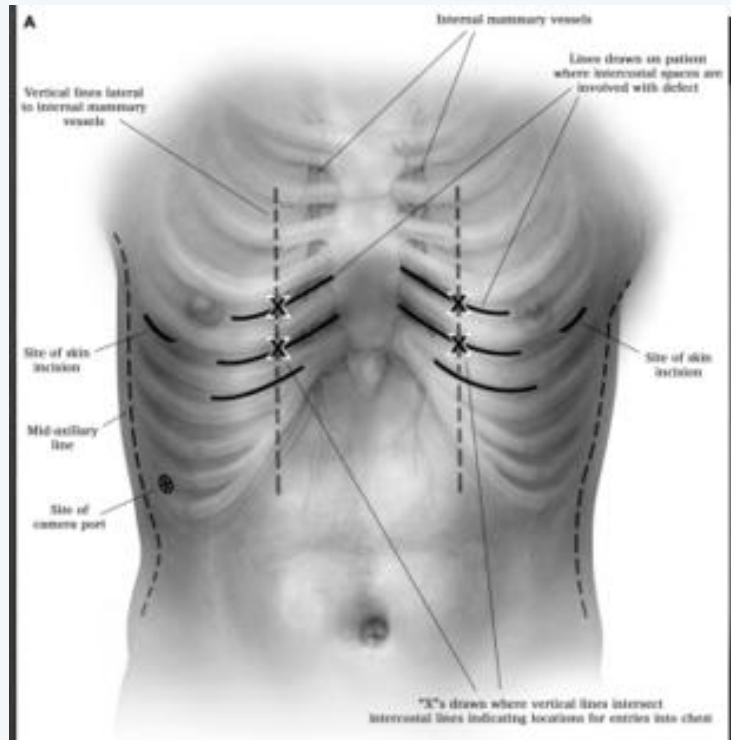
- The first surgical intervention of pectus excavatum
  - Wilhelm Meyer in 1911
  - Resected Rt 2<sup>nd</sup> and 3<sup>rd</sup> costal cartilages
  - Significantly improved dyspnea
- Sauerbruch performed a more radical procedure in 1913
  - 5<sup>th</sup> to 9<sup>th</sup> costal cartilage, left hemisternum
- Judet in 1954 performed a sternal turn-over procedure
  - Reattaching the resected sternochondral apron in the anterior chest wall: Juro Wada

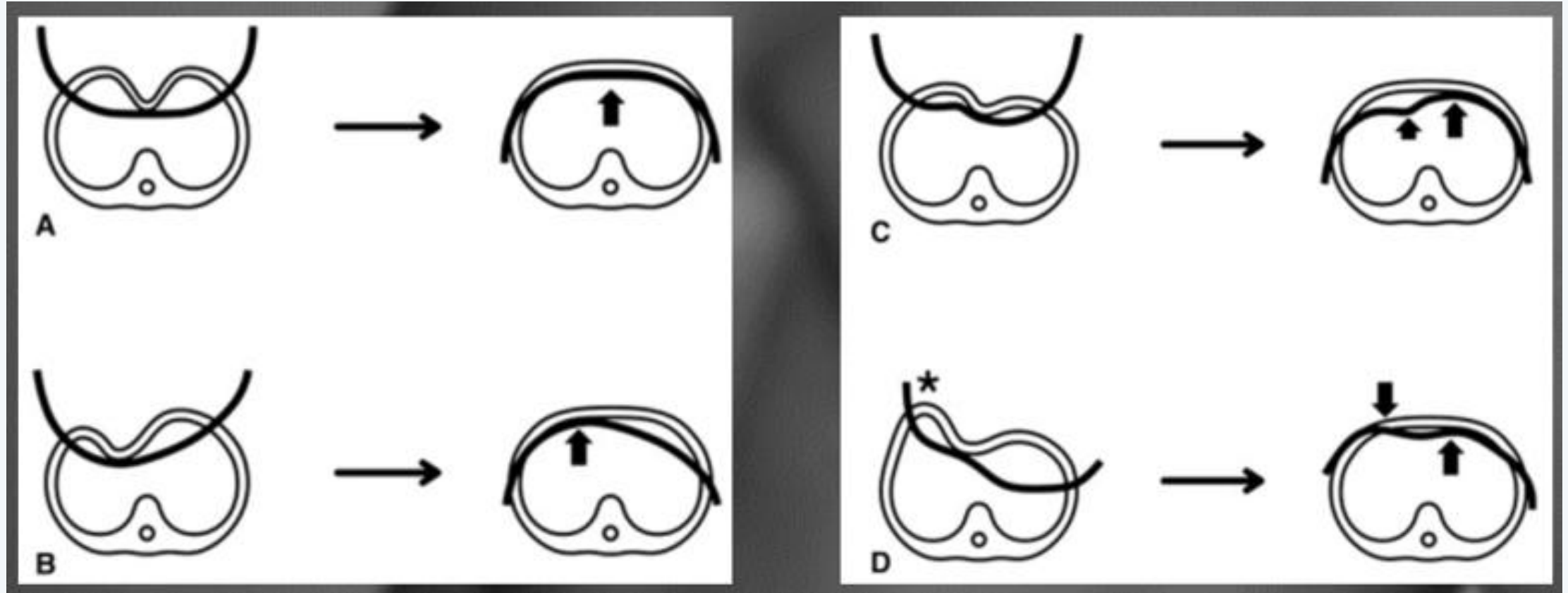
- Less than satisfactory late outcomes
  - Corrected position of sternum using substernal support
  
  - The principles of modern pectus excavatum surgery
  - Ravitch in 1949
1. Removal of deformed cartilages
  2. Division of xiphisternal articulation
  3. Transverse cuneiform osteotomy of the sternum at the upper level of the deformity
  4. Maintenance of the corrected position of the sternum





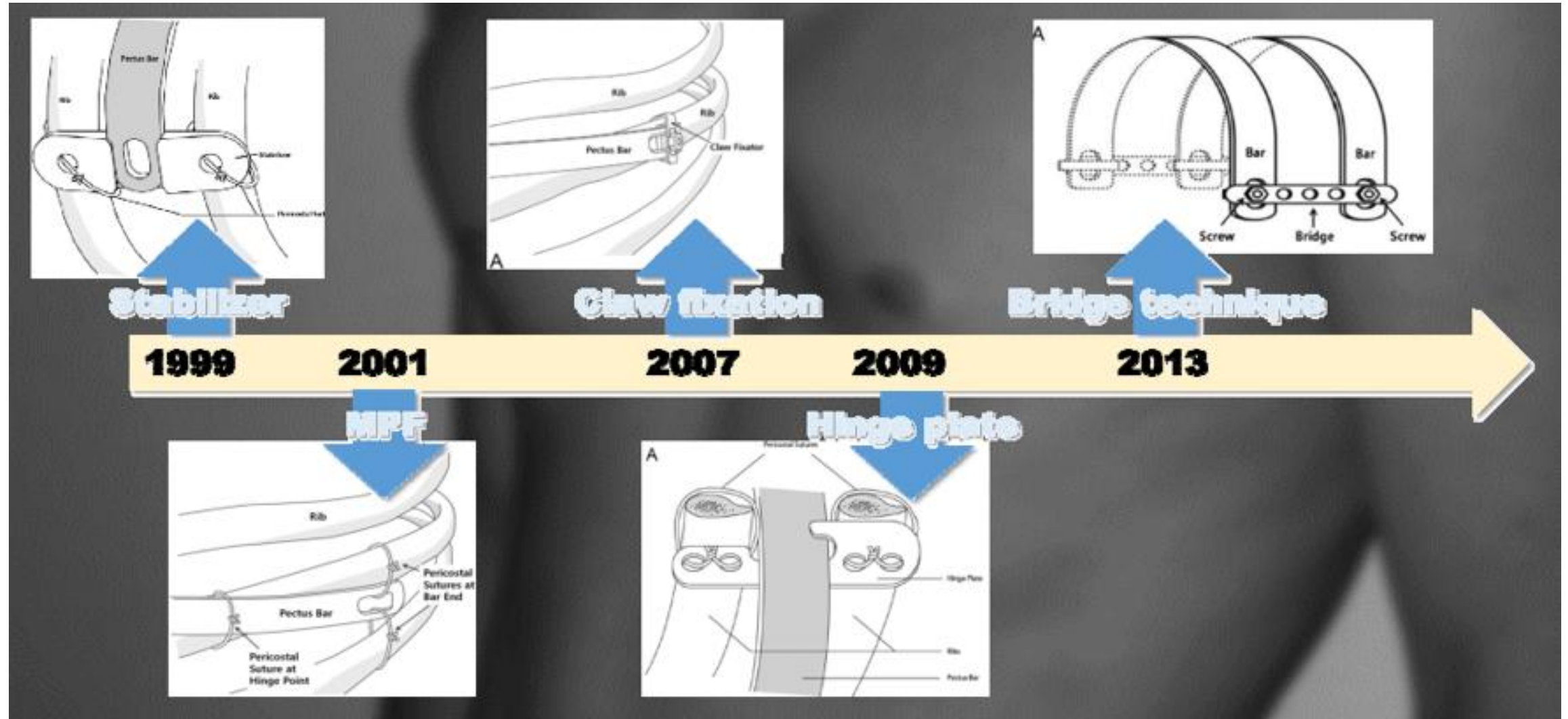
# Minimally Invasive Repair of Pectus Excavatum by Donald Nuss in 1998





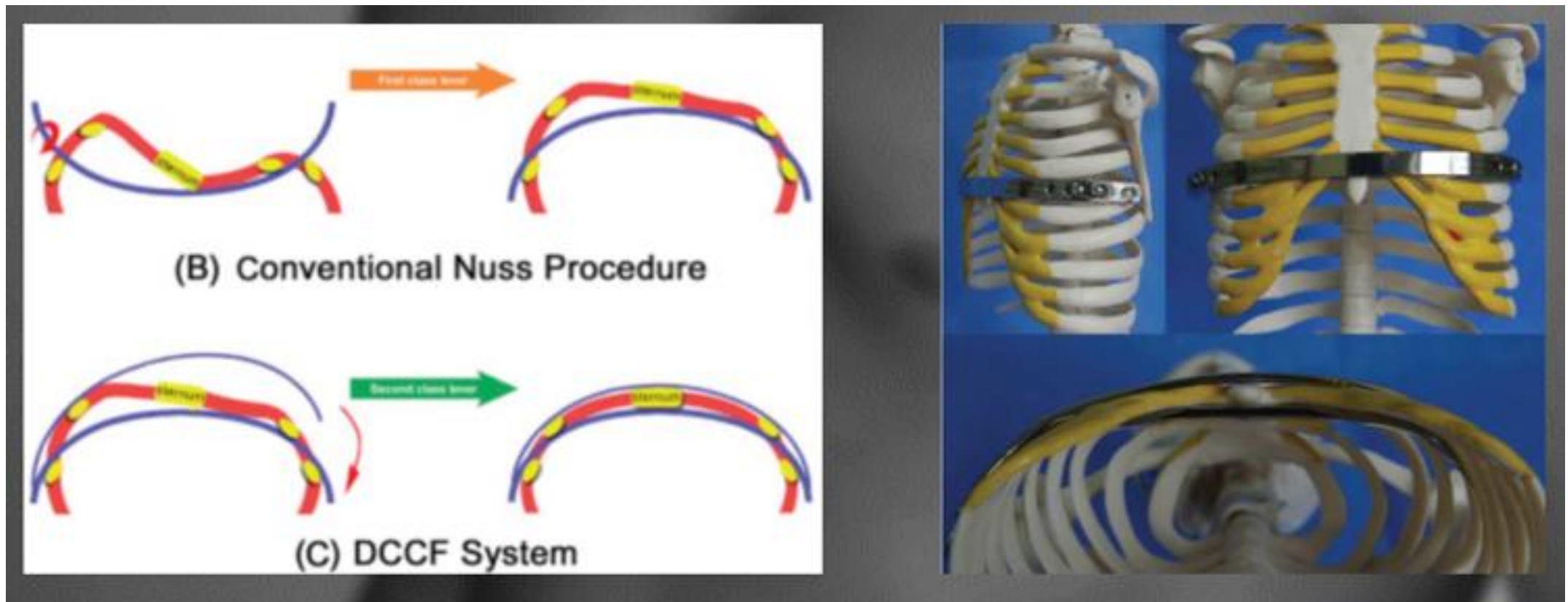
**Morphology tailed bar shaping**

# HJ Park's Technique



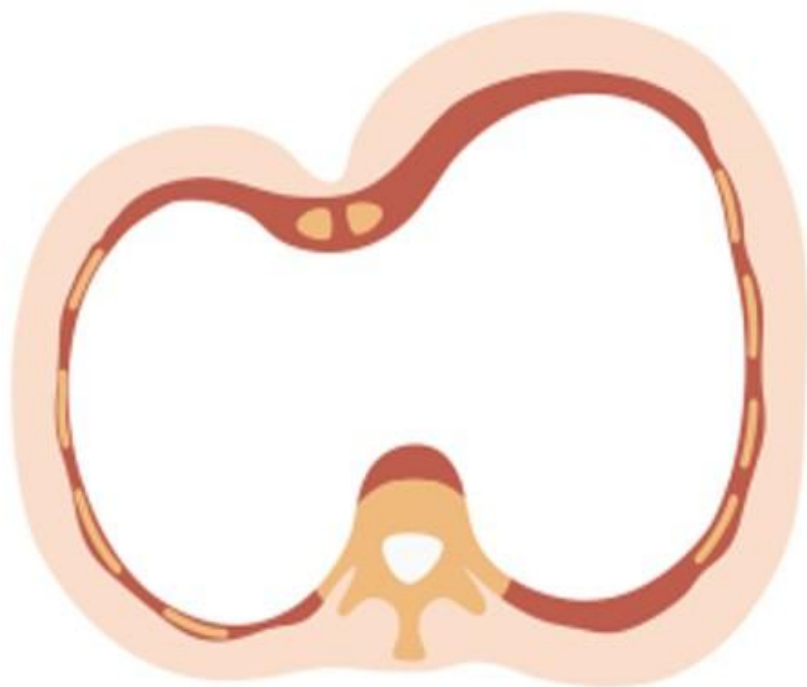
# SS Lee's Technique

**Double Compression and Complete Fixation bar system (DCCF) or Coaxial-Double Bar**



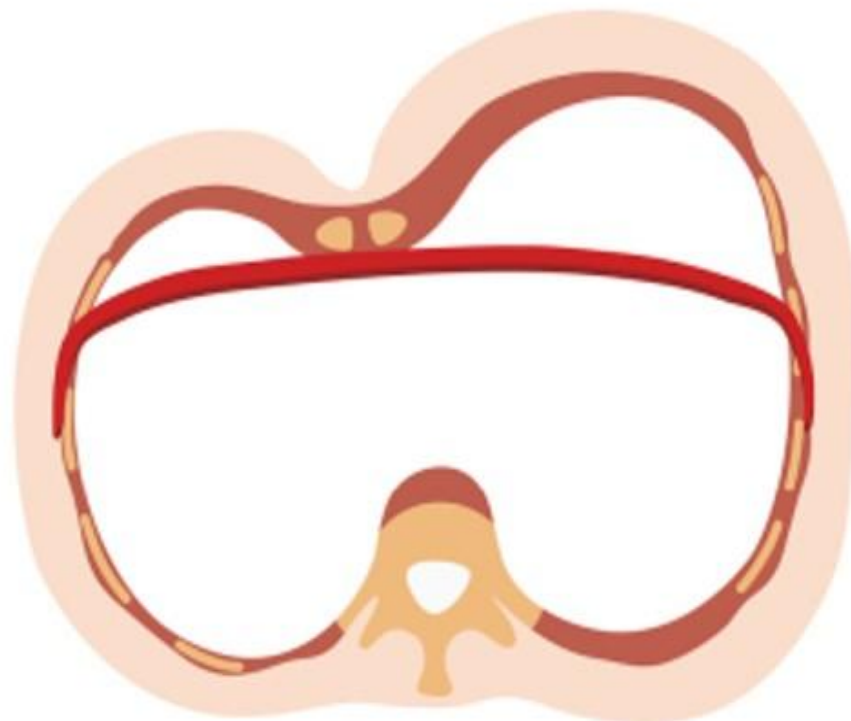
A

Preoperative asymmetric PE



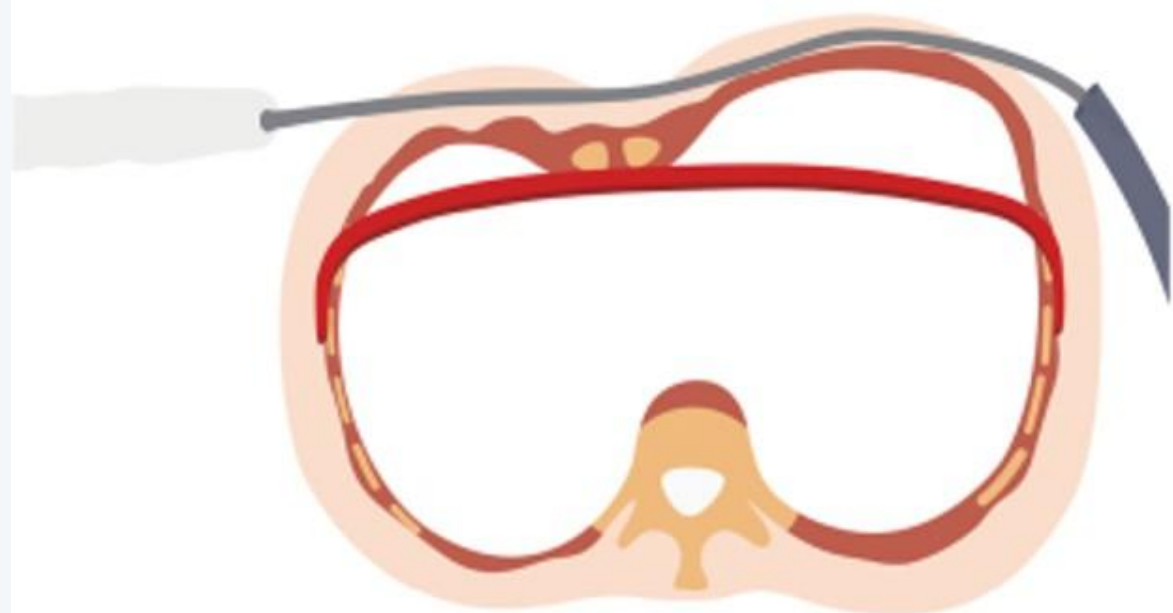
B

Under-bar insertion



C

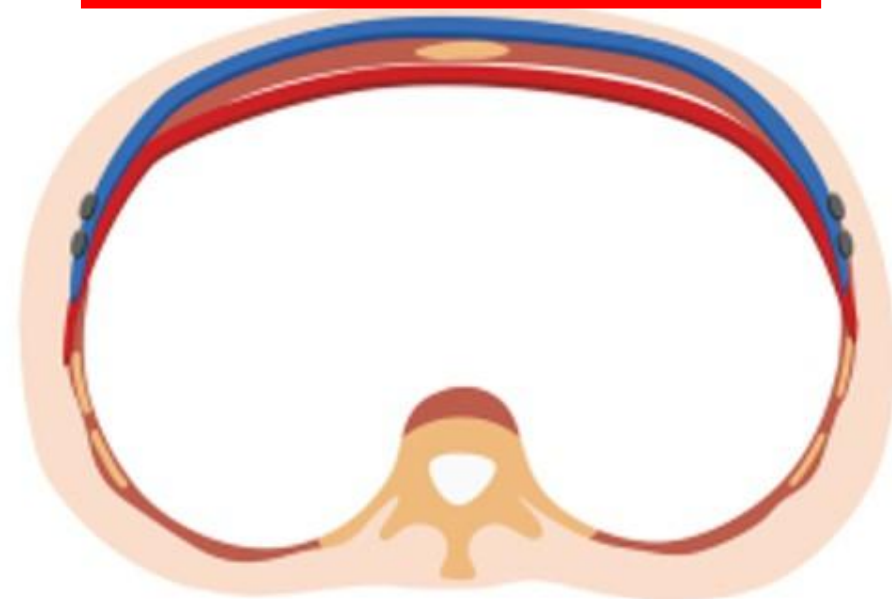
Subcutaneous tunneling



D

Post-double-bar insertion

**Coaxial double bar**



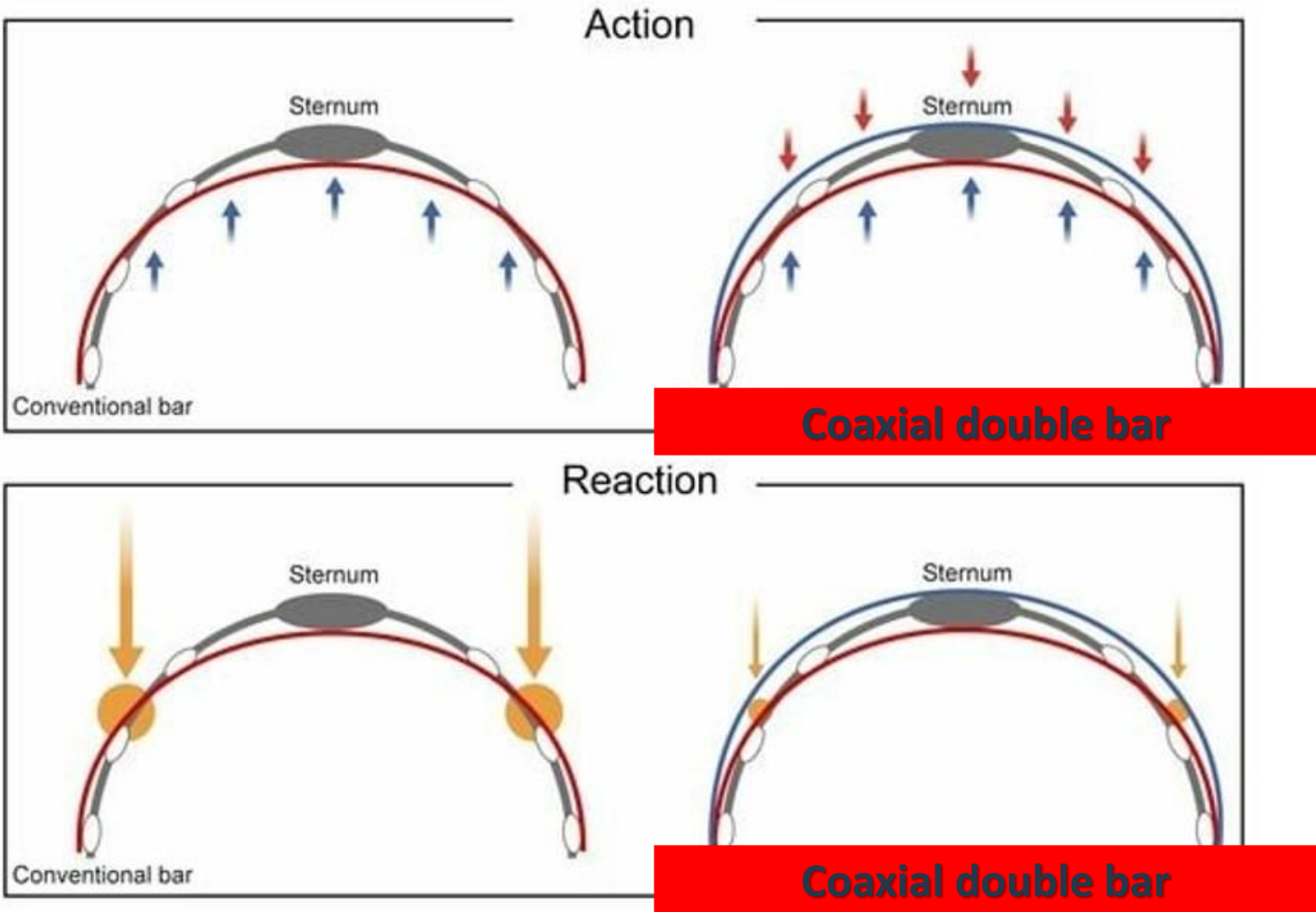
E

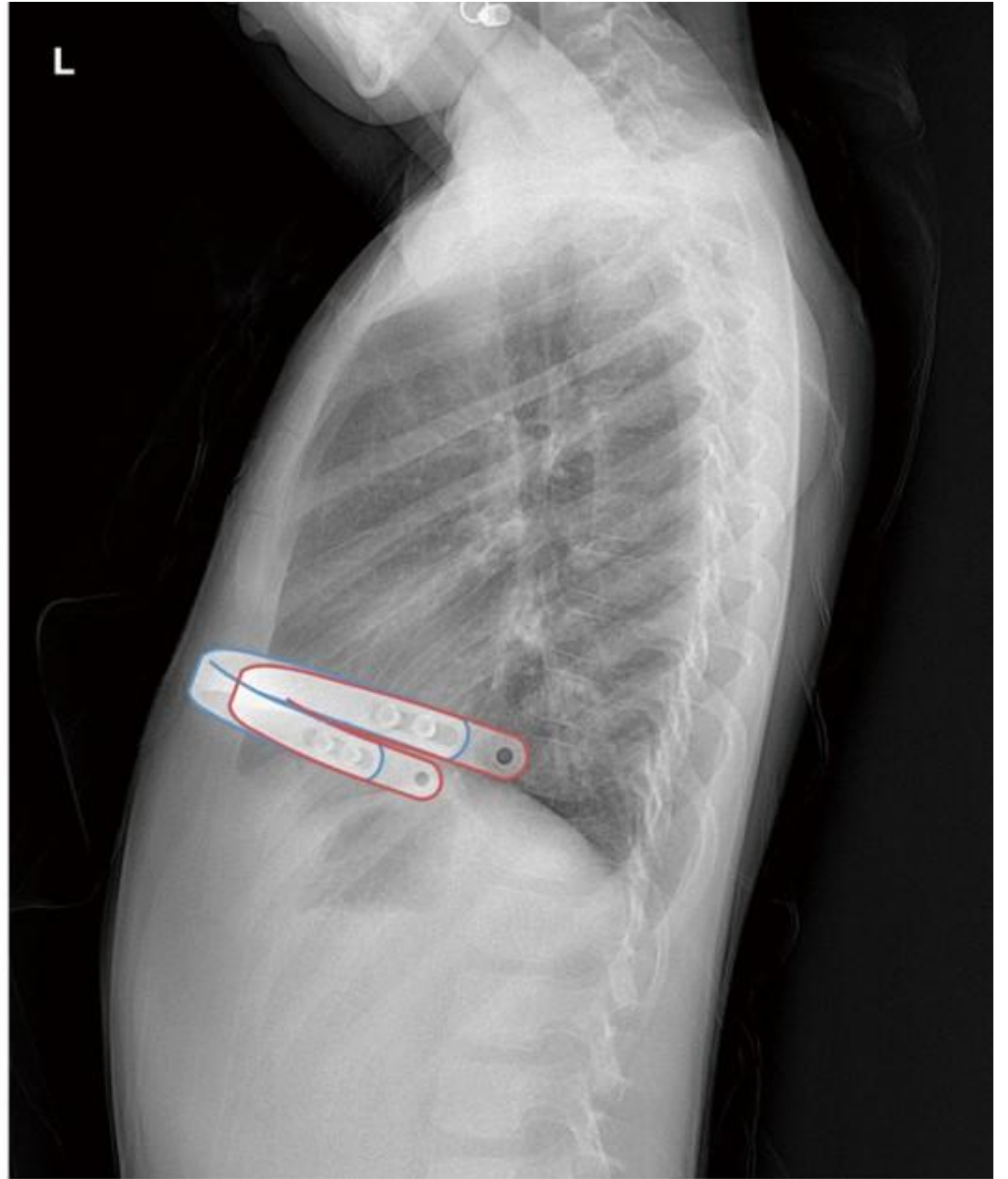
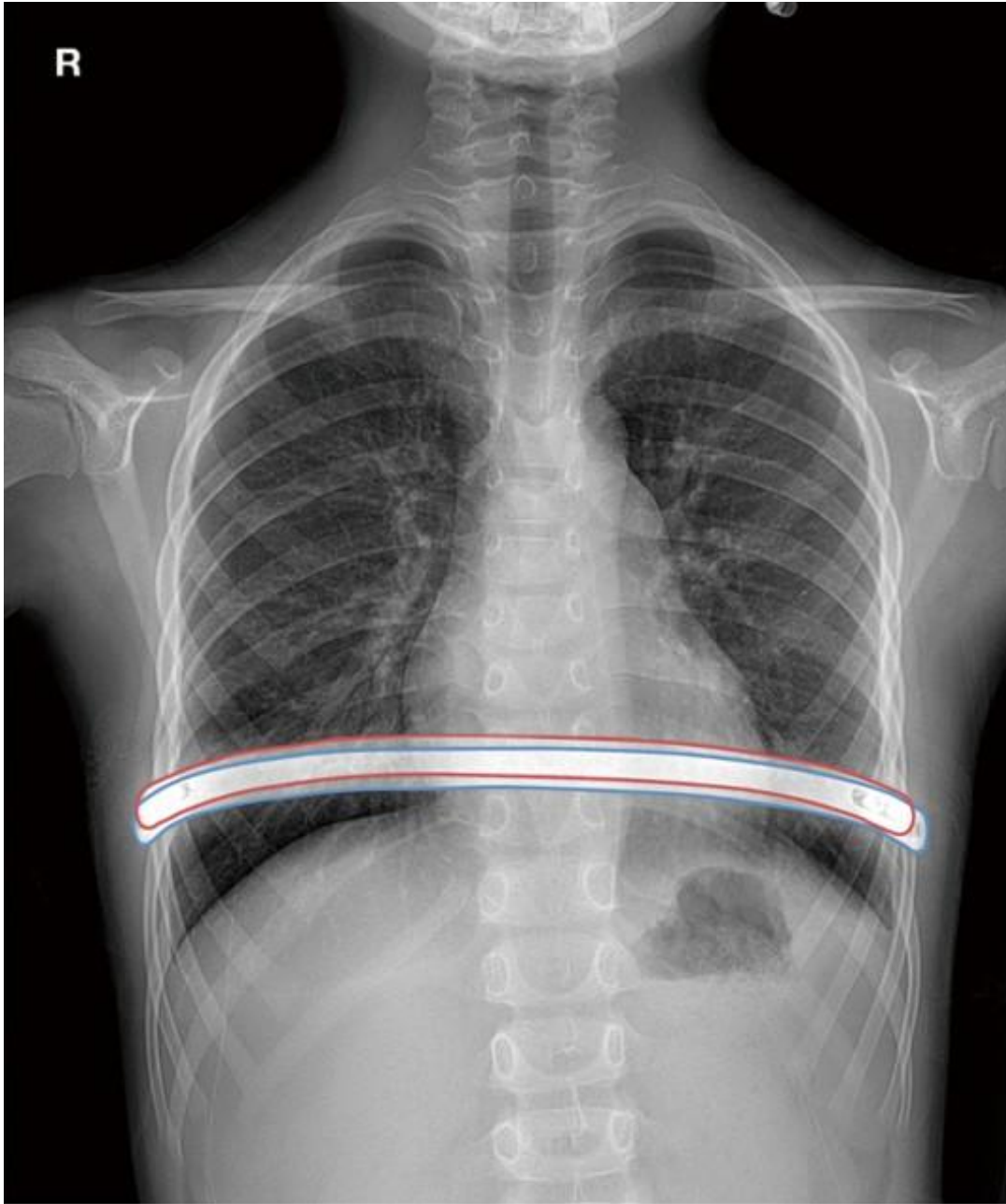
Bar fixation with inter-bar screw



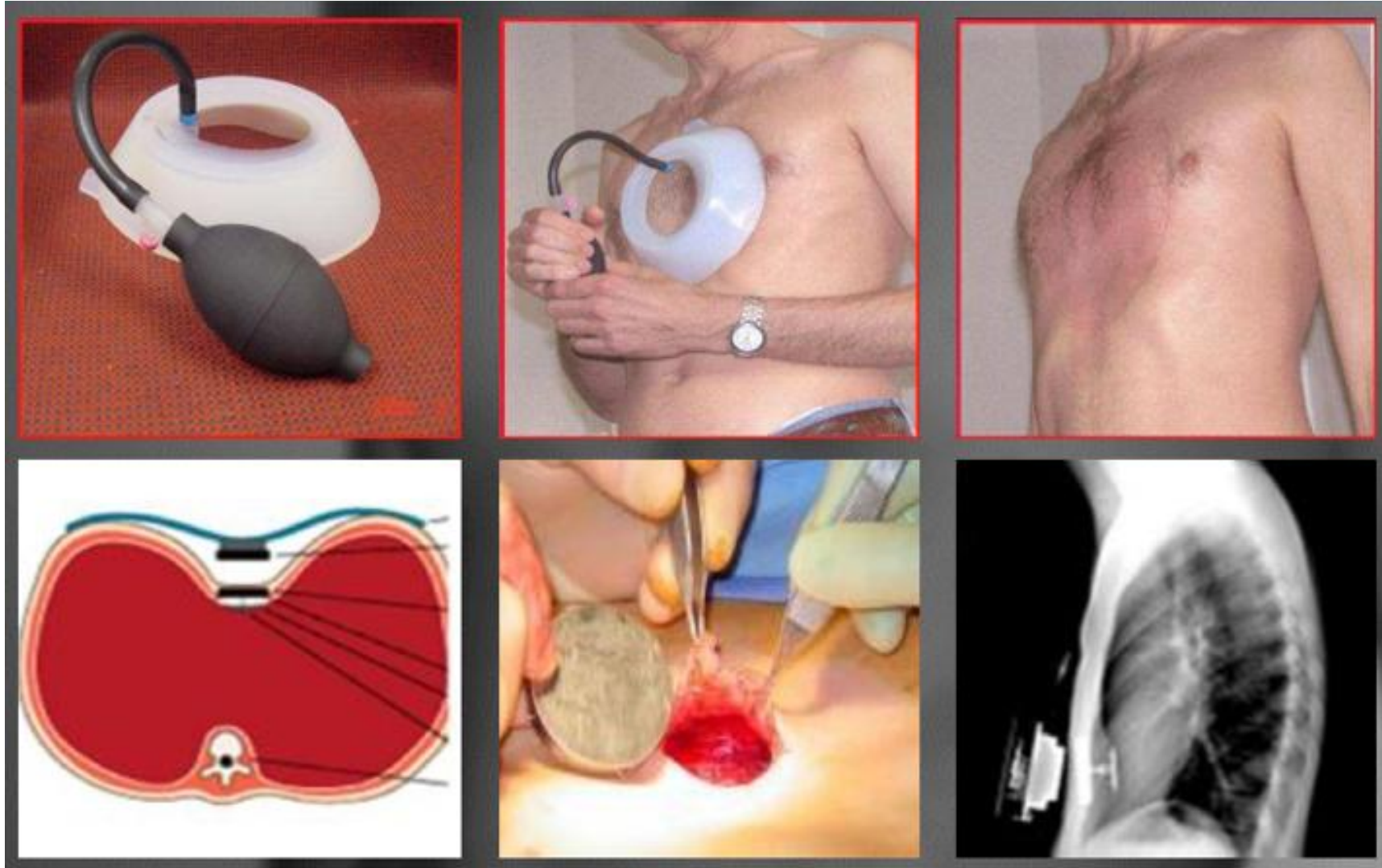
Approximator

# Coaxial double bar





# Vacuum Bell and 3MP



**Thank you for your attention**