Immediate Rib Fixation for Multiple rib fracture with/without Fail Chest

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박 준 석

Rib ORIF for Flail Chest

- **Increasingly becoming an accepted Tx. Modality for severe chest trauma**
  - **Mechanical ventilation(MV) for thoracic stabilization was standard treatment**
  - **Poorly healed fractured rib can lead to chronic pain, disability and deformity**
  - **Evidences regarding superior recovery in FIX patient (less ICU stay, less pain, better performance, etc)**
- **Not yet widely accepted as standard care**
  - **Lack of awareness of evidence, knowledge of surgical technique and specific prosthesis**
  - **Previous unhappy experience regarding wiring, cerclage suture, or other failed prosthesis**

MV vs. Rib ORIF, When? How?

- **Decision of surgery**
  - **Immediately after diagnosis of Flail chest?**
  - **After MV applied?**
  - **After MV has failed?**
  - **Insurance coverage?**

- **Specific indication**
  - **Agreement for specific indication?**
  - **How many ribs?**
  - **What prosthesis?**

Personal Preference

- **Temporary MV also requires sedation / pain control**
- **Patients still suffer for discomfort by intubation and immobilization**
- **MV takes at least a week for thoracic cage stabilization**
- **Some of MV patients need surgery at last.**
- **Early surgery (ASAP) may save suffer, time and money**
  - **Prevent respiratory muscle wasting -> early wean –off from MV**
  - **Also preserve functionality, performance.**

Indication of Surgery

- **Flail chest which requires mechanical ventilation**
- **Segmental rib fracture confirmed by P/Ex. or imaging study**
- **Combined Hemo/pneumothorax**
- **No contraindication of surgery by co-morbidity**

- **Severe pain with confirmed multiple fracture/dislocation**

- **Organ injury d/t severely displaced fractured segment**

Contraindication of Surgery

- Severe head trauma
- Spine injury precluding positioning for surgery
- Open dirty wound
- Sepsis / bleeding tendency / DIC
- Other condition enforcing long term MV

Patients

- From Feb. 2013
- 12 patients with chest trauma
  - Multiple rib ORIF
  - By pre-mentioned indication
- All Male
- Age from 42 to 83 (median 59)

Patients

- **Indication**
  - **Flail chest: 7**
  - **Severe pain with deformity: 3**
  - **Ongoing hemothorax with dislocation: 1**
  - **Liver injury by dislocated rib with flail: 1**

- **Combined injury requiring surgery: 6**
  - **2 Liver injury / 1 clavicle / 1 pelvic / 2 facial bone**

- **Timing of surgery: 11hr ~ 240hrs**
  - **Median 24 hrs**
  - **Preop. Intubation: 8 (3 with NIV: Pt. request)**

Outcome

- **No. of fixed rib: 2~5 (median 4)**
- **No. of plate: 2 ~ 7 (median 4)**

- **Lt. / Rt : 5 / 7**

- **Type of plate**
  - **Early 3 Pts.: Clavicle plate**
    - **125/225/230 min**
  - **Late 9 Pts: Sternalock system**
    - **Direct screwing**
    - **60 ~ 120 min (median 75 min)**

Outcome

- **PostOP ICU stay: 1 ~ 13 day (median 1 day)**
  - **Pt. with liver rupture stayed 13 days for GS OP.**
- **PostOP MV duration**
  - **7 immediately extubated after surgery**
  - **2 for 77 & 243 hours d/t OS / PS (facial) surgery**
  - **2 for 22 & 77 hours d/t delirium**
  - **1 for 14 hours d/t old age (83 yrs)**
- **PostOP Hospital stay: 3 weeks average**
- **PostOP CTD duration: 3 ~ 30 days (median 6 days)**

Outcome

- OPD analgesics requirement
  - No to minimal: 9
  - Routine medication as post-thoracotomy: 1
  - Heavy pain with long-term medication: 2
    - 1 in delayed surgery (10 days after injury)
      - Calus formation / partially healed
    - 1 with un-correctable juxta-vertebral fracture (near rib head)

Images

Conclusion

- **Surgical fixation of heavy chest trauma could offer superior outcome over conventional conservative treatment.**

- **Immediate surgical fixation may have benefit for reducing mechanical ventilation, ICU stay and ongoing pain.**

Strategies for Needlescope-Assisted 3-Point Fixation to Prevent Bar Displacement in Nuss Operation

가톨릭대학교 인천성모병원 정진용

OBJECTIVE: Bar displacement is one of the most common complications after Nuss operation for pectus excavatum. We described the techniques of needlescope-assisted bar fixation.

METHODS: We performed needlescope-assisted 3-point fixation of the single bar without additional incision in 30 patients with pectus excavatum from May 2012 to August 2014. There were several strategies to fix the bar onto the anterior chest wall. First, direct suture was done with one thread of No. 5 Ethibond when the chest wall was enough thin for a needle to pass as in young child. Second, when the chest wall was thick as in old child, endo-needle holder was used to penetrate the chest wall with one thread of suture from inside to outside. Third, Deschamps needle was applied to use two threads fixation when musculoskeletal force was strong as in adolescent and adult. Forth, endo-needle holder was used to hold the needle twice in adolescent and adult with narrow rib and intercostals space. We measured the position of the pectus bar with the angle degree on the lateral view of chest radiograph.

RESULTS: A mean age of 30 patients (male 26, female 4) was 11.3 ± 8.7 years (range: 3 to 36 years). The pre-operative and post-operative HI were 3.91 ± 1.03 and 2.64 ± 0.44, respectively. One patient underwent reoperation to correct the bar displacement, which showed 3.3% of corrective surgery rate.

CONCLUSIONS: Needlescope-assisted 3-point fixation of the bar was performed without additional skin incision and showed 3.3% of reoperation rate to correct the pectus bar displacement.

A Method to Make the Pectus Bar Displacement Rate "Zero" : A Dream or Reality?

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BACKGROUND

- **Pectus Bar Displacement:**

  The Crucial Determinant for Successful PE Repair.

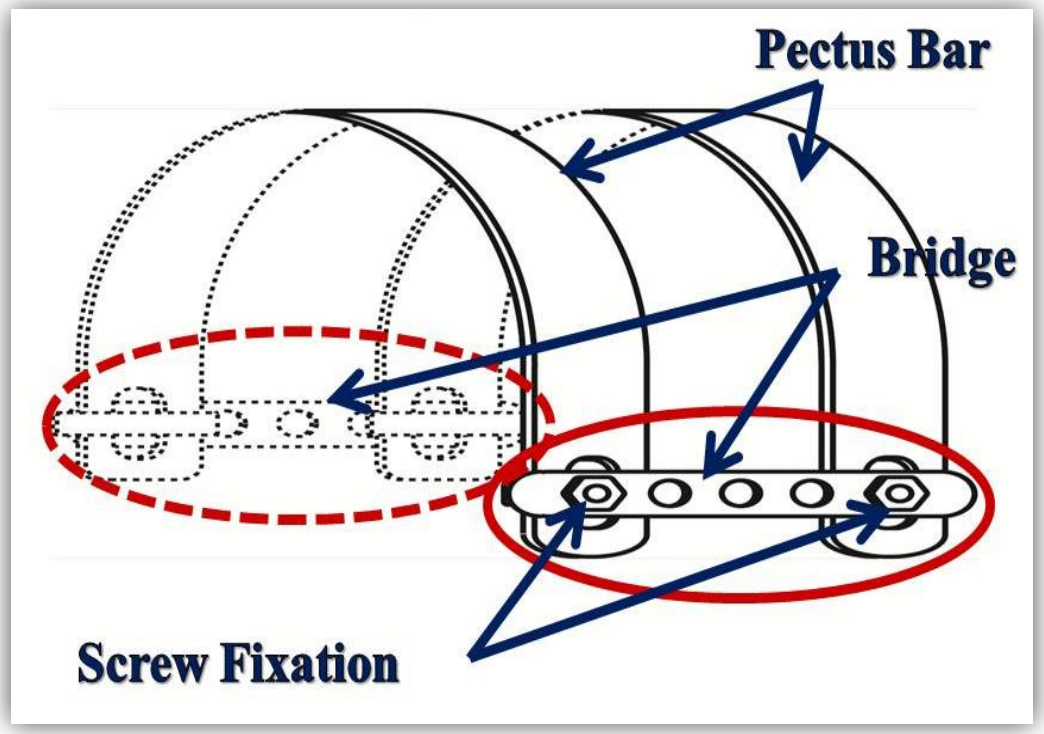
- **A New Technique:**

  “Bridge Connection of Two Bars” to Make Bar Displacement Rate of “Zero”

BACKGROUND

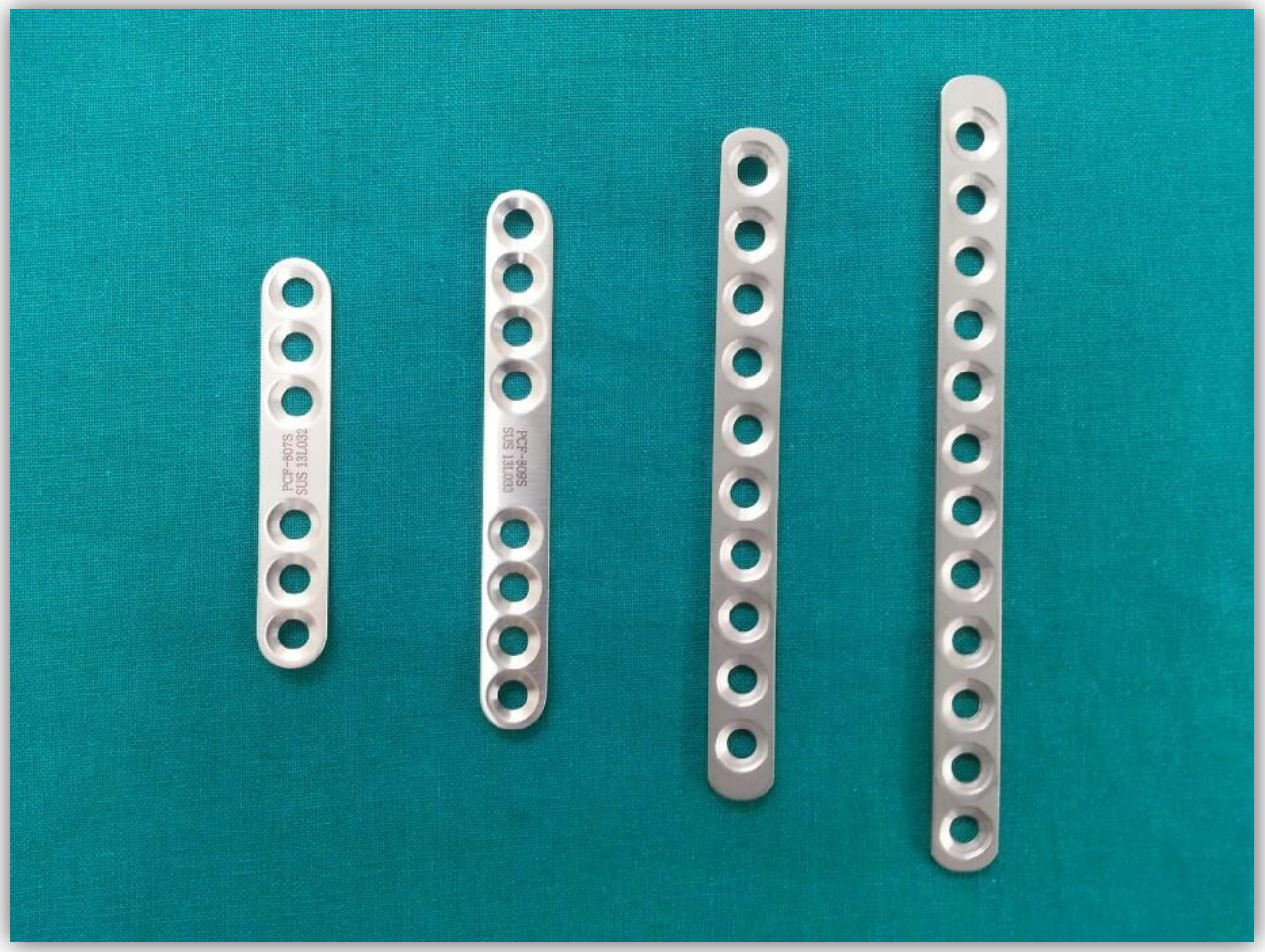
- A New Technique: Metal Plates + Screws
- No Fixator !
- No Suture !
- No Effort !
- The Purpose of This Study: Appraisal of Bridge Fixation Technique

SURGICAL TECHNIQUE

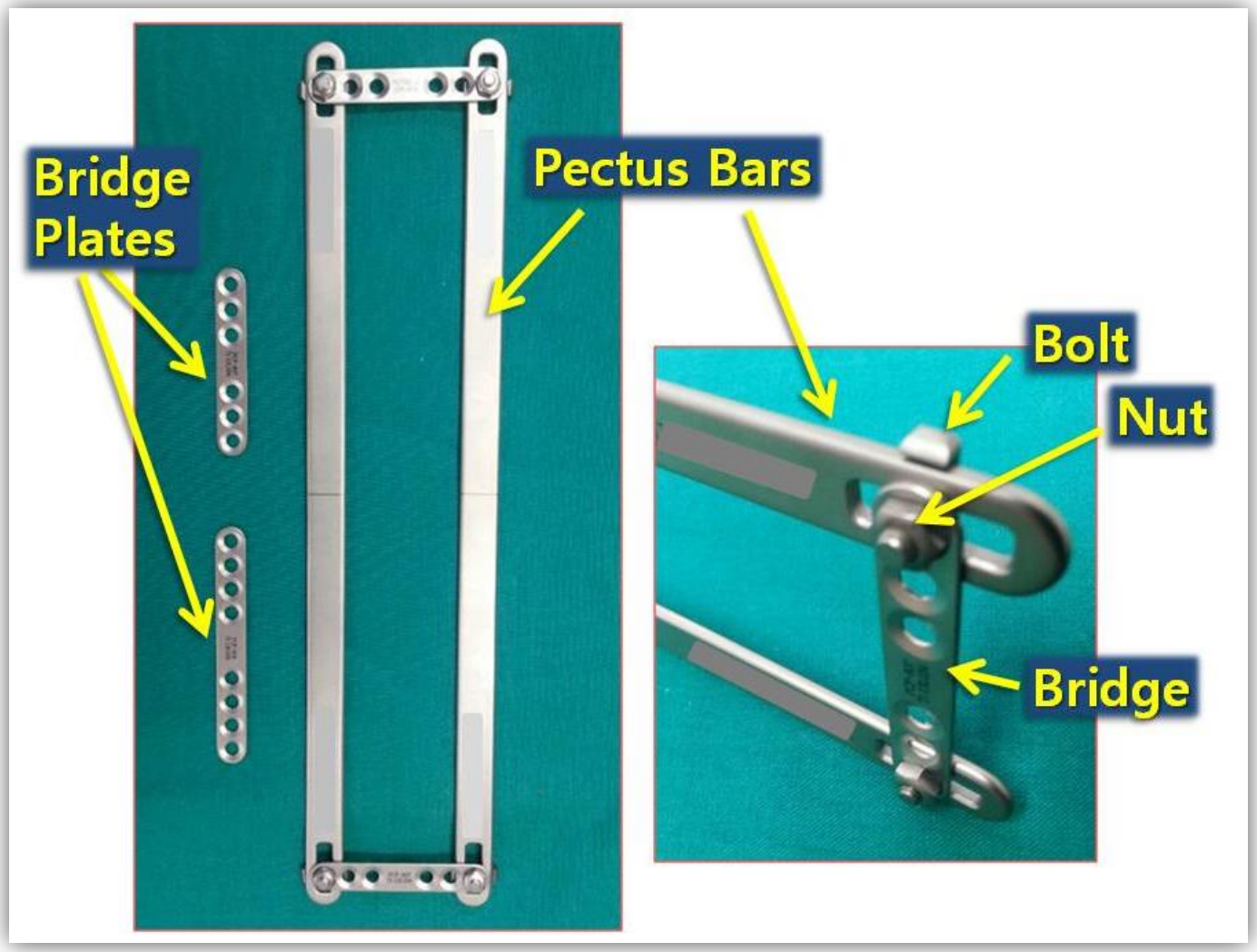


Bridge fixation technique connecting parallel bars with metal plates and screws.

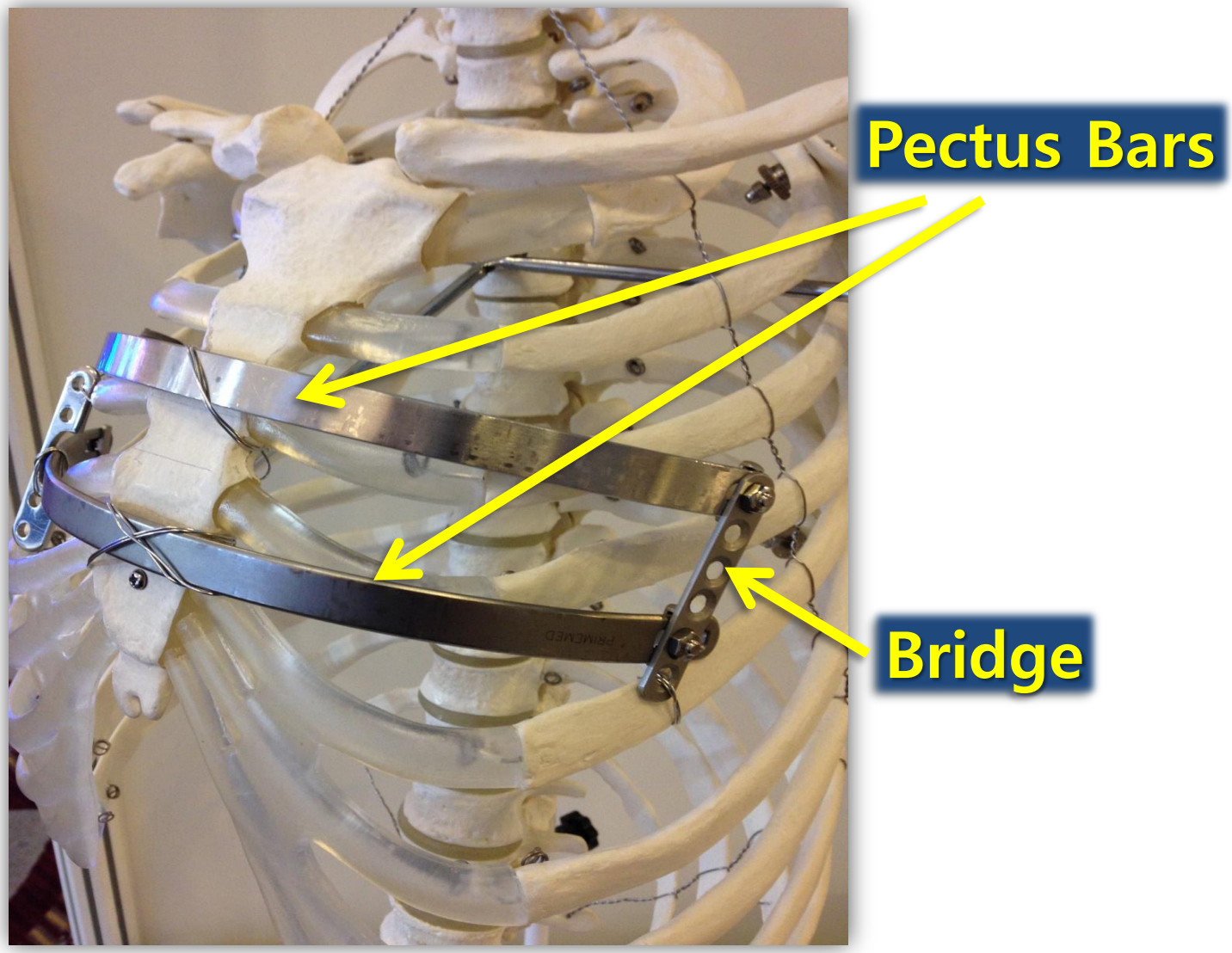
Bridge Plates



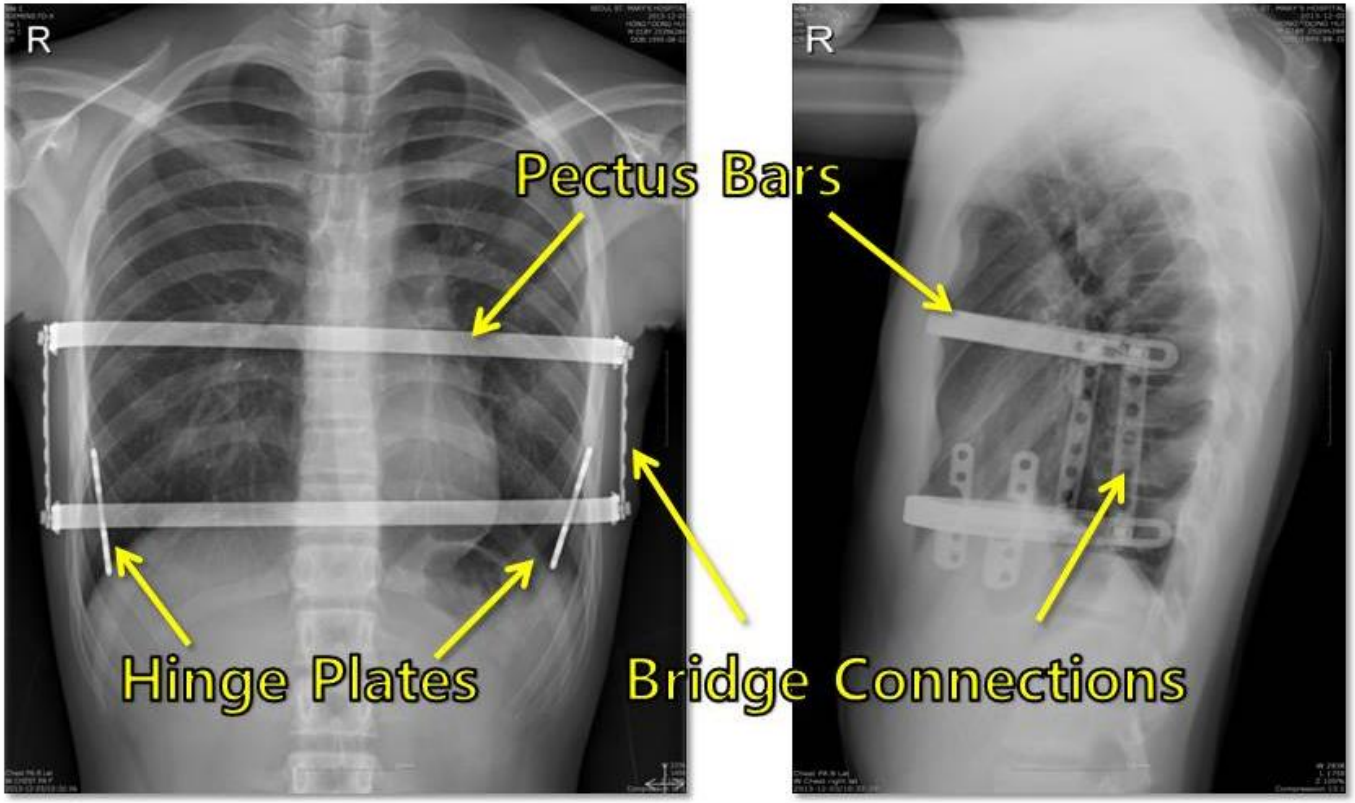
SURGICAL TECHNIQUE



SURGICAL TECHNIQUE



SURGICAL TECHNIQUE



MATERIAL & METHODS

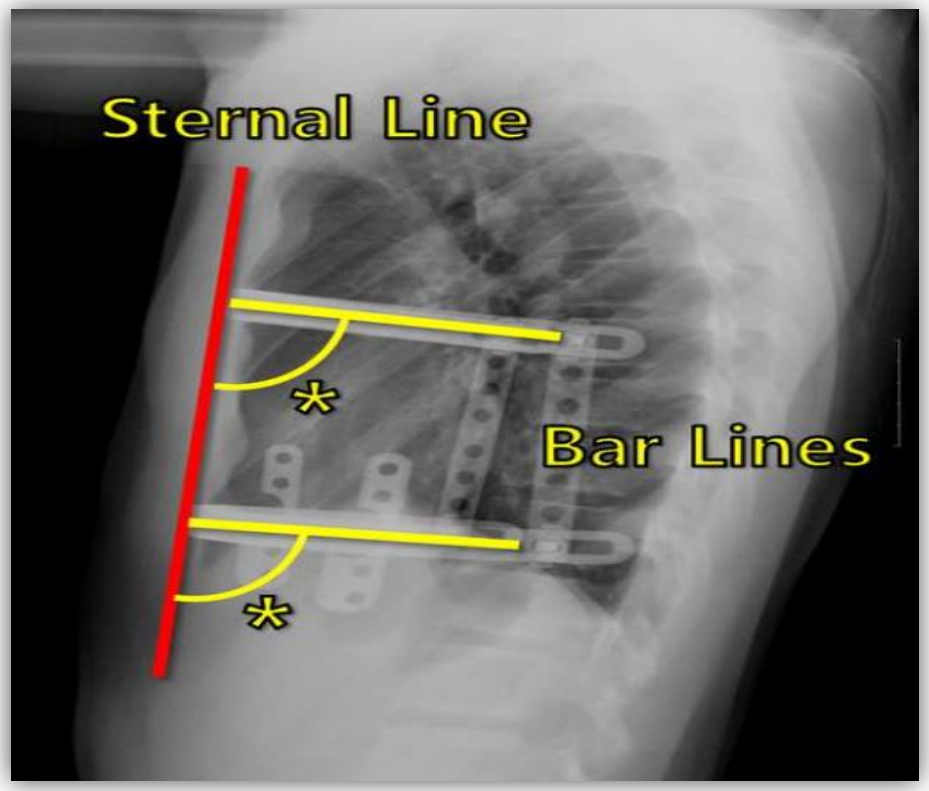
- 137 patients, July 2013~Jan. 2015
- Parallel Bar Technique using 2 Bars
- M:F = 8
- Mean age: 17.5 yr (5~55 yr)

  120 adults (12> yr, 87.6%)
- Asymmetric type: 84(33.5 %)

  Grand Canyon type: 46 (33.5 %)

Bar Stability Assessment

- Comparing Angles (*) between Sternum and Pectus Bars on PO 5days (POD5) vs. PO 4 Months (POM4)



RESULTS

- Pectus Bar Displacement = 0
- No Specific Complications Related with the Bridge
- Comparison of Sternum-Bar Angles:

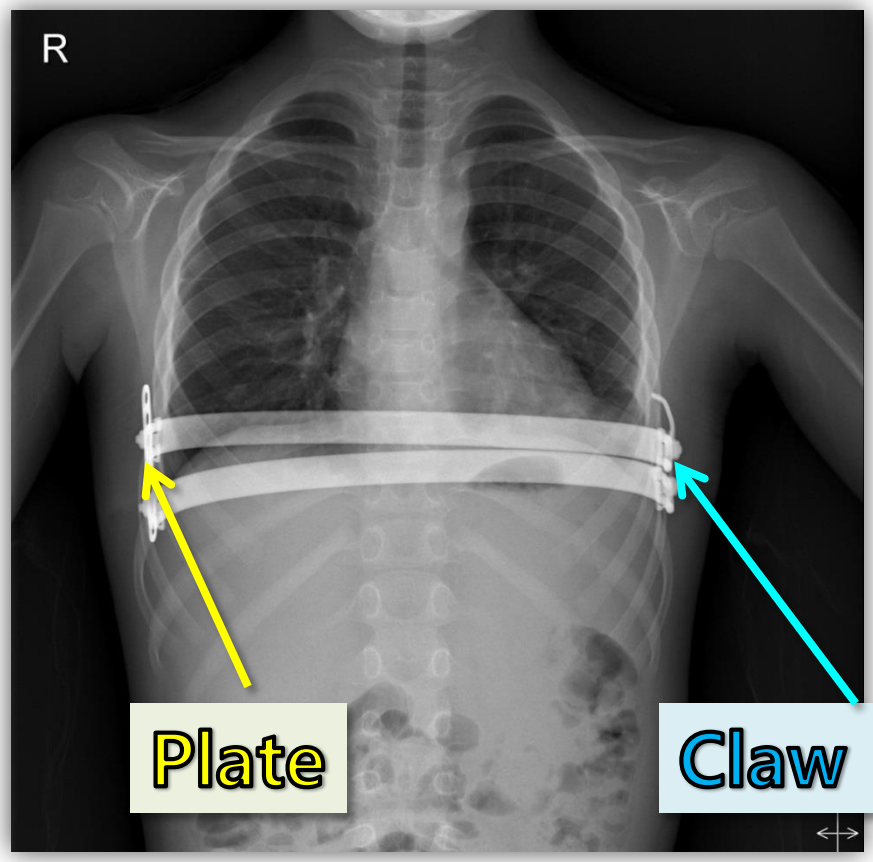
  POD5 vs. POM4 = <1 °, No Difference

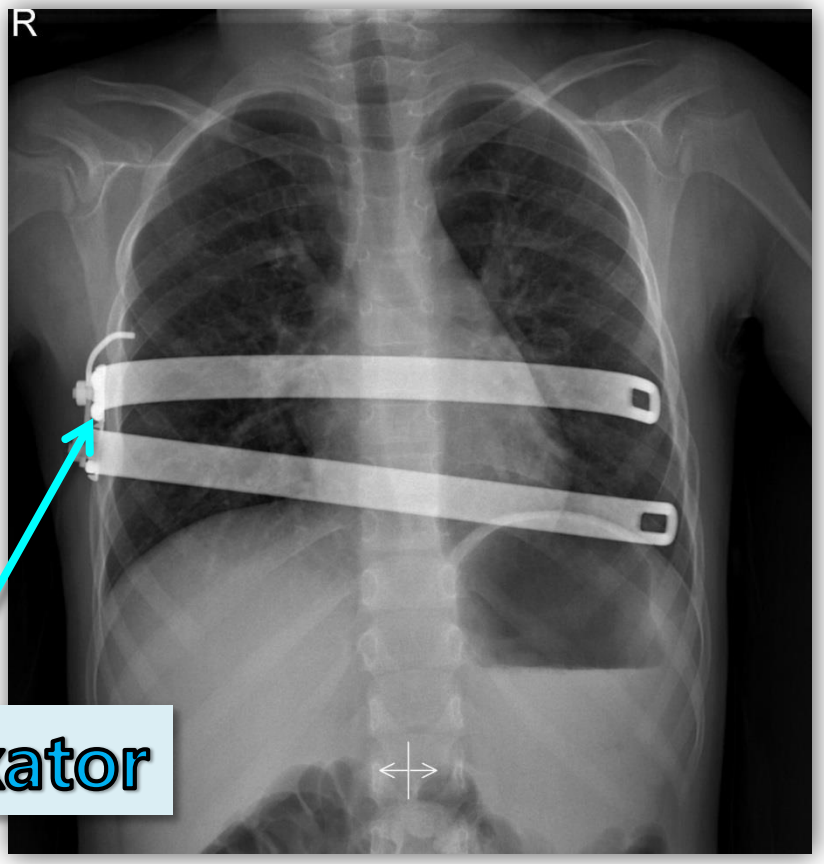
RESULTS

	POD5	POM4	Difference	p
Upper Bar	86.66 ± 5.31	86.89 ± 5.40	0.23	0.602
Lower Bar	92.39 ± 5.14	92.04 ± 5.22	0.35	0.338

Virtually No Movement of the Pectus Bars 4 Months After Operation

Mini-Bridge





5/M, 1A

5/F, 2BL

CONCLUSIONS

- The Bridge Connection between Parallel Bars:

  A Method to Make the Bars Utterly Un-rotatable

- Easy to implement, Suture-less:

  Non-invasive Extra-thoracic Bridge Placement

- The Mission Accomplished:

  Bar Dislocation Rate = Zero

Scoliosis after Pectus Excavatum Correction : Does it become better or worse?

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2 Department of Thoracic and Cardiovascular Surgery, Seoul St. Mary's Hospital, The Catholic University College of Medicine

Background

- Scoliosis is frequently associated with pectus excavatum
  - AIS in PE : 11.5~22.58% (normal : 0.5~3%)

- Incidence of scoliosis is related to severity & asymmetry of chest wall deformity, age
  - Haller index>3.5 (19.35%) vs Haller index<3.2 (10.53%)
  - Age>11Y (21.79%) vs age<11Y (6.06%)

- Reported cases on acquired thoracic scoliosis after Nuss operation Niedbala et al.

Objectives

- Change in degree of scoliosis after the correction of pectus excavatum has not been clarified

- To evaluate the influence of pectus excavatum correction on pre-existing scoliosis

Methods

- Retrospective study
- Between January 2007 and March 2009
- 423 Pectus excavatum patients operated using Pectus bar
- Exclusion criteria :
  - Patients with congenital deformities of the spine (hemivertebra, cerebral palsy) or connective tissue disorders (Marfan's disease) were excluded.

- Evaluation of preoperative and postoperative degree of PE and scoliosis :

  => chest CT, chest posteroanterior radiography

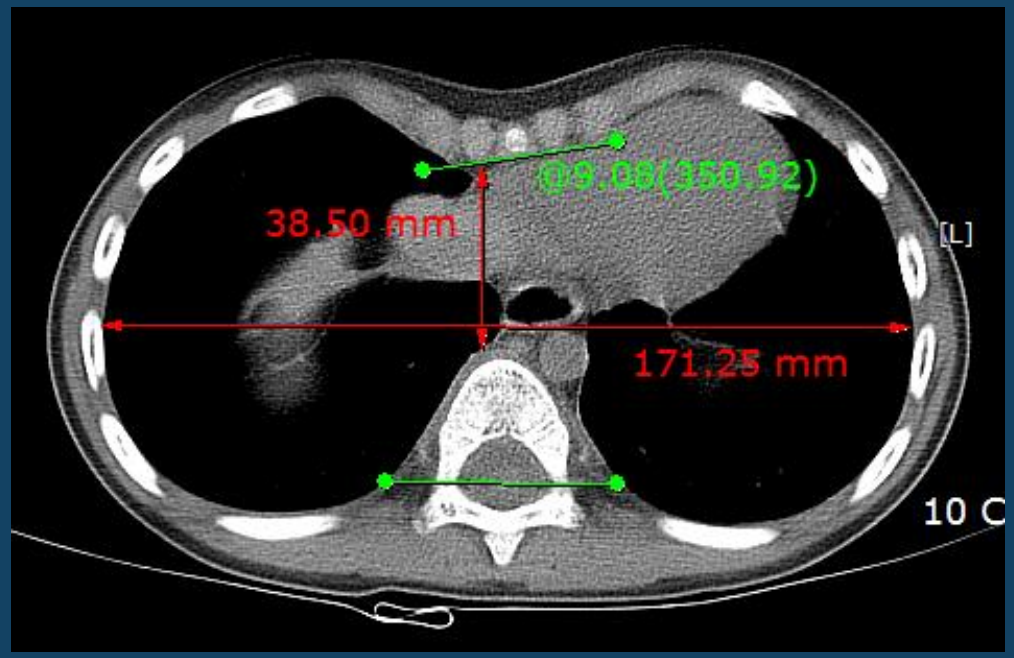
- Evaluation of changes in degree of scoliosis & PE

  Group 1 : mild scoliosis (Cobb angle<15°)

  vs

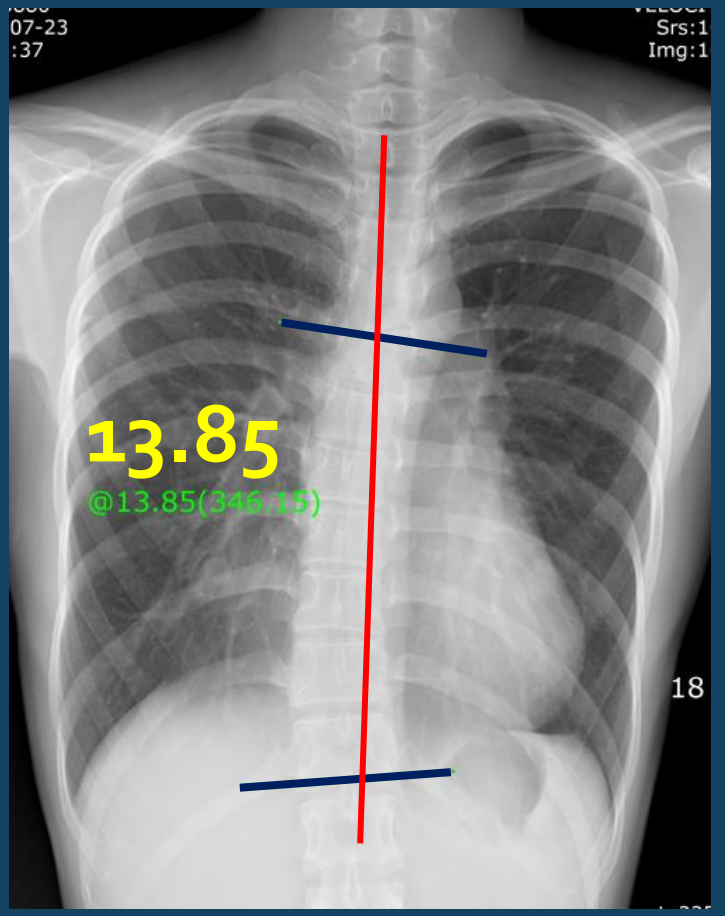
  Group 2 : severe scoliosis (Cobb angle>15°)

Measurements



Haller index

Sternal tilt



Cobb angle

Results

Patient Characteristics

	Mild Scoliosis (CA<15)	Severe scoliosis (CA>15)	Combined	p
N	28 (6.62%)	6 (1.42%)	34 /423 (8.04%)	
Age	18.14	16.83	17.91	0.707
Sex (Male:Female)	14:14	4:2	18:16	0.660
Cobb angle	12.14	19.78	13.49	<0.001
Sternal tilt	14.81	10.55	14.06	0.416
Haller index	5.01	7.28	5.41	0.287
Asymmetry	16 (57.1%)	4 (66.7%)	20/34 (58.8%)	1.000
Multiple bar	11 (39.3%)	2 (33.3%)	13 / 34 (38.2%)	1.000

Correlations

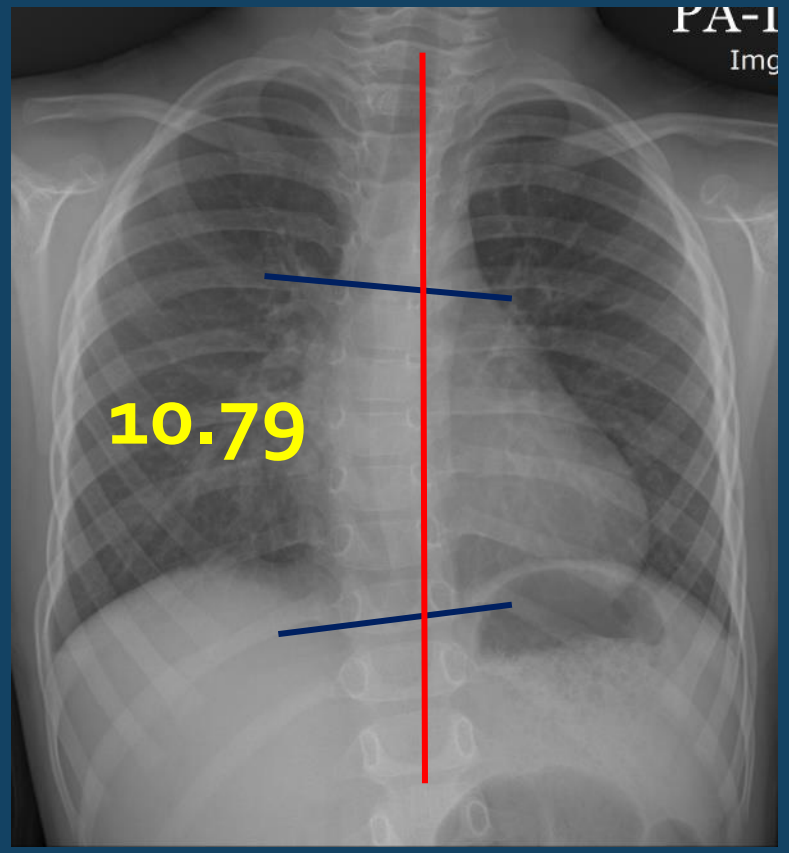
		H index	S tilt	Cobb angle	Change in HI	Change in ST	Change in CA
H index	r	1	-0.05	0.452	0.955	0.271	-0.211
	P		0.976	0.007	0.000	0.122	0.231
S tilt	r	-0.005	1	-0.015	-0.048	0.408	0.066
	P	0.976		0.935	0.787	0.017	0.709
Cobb angle	r	0.452	-0.015	1	0.469	0.065	-0.494
	P	0.007	0.935		0.005	0.715	0.003
Change in HI	r	0.955	-0.048	0.469	1	0.325	-0.161
	P	0.000	0.787	0.005		0.061	0.363
Change in ST	r	0.271	0.408	0.065	0.325	1	-0.006
	P	0.122	0.017	0.715	0.061		0.973
Change in CA	r	-0.211	0.066	-0.494	-0.161	-0.006	1
	P	0.231	0.709	0.003	0.363	0.973	

Postoperative change

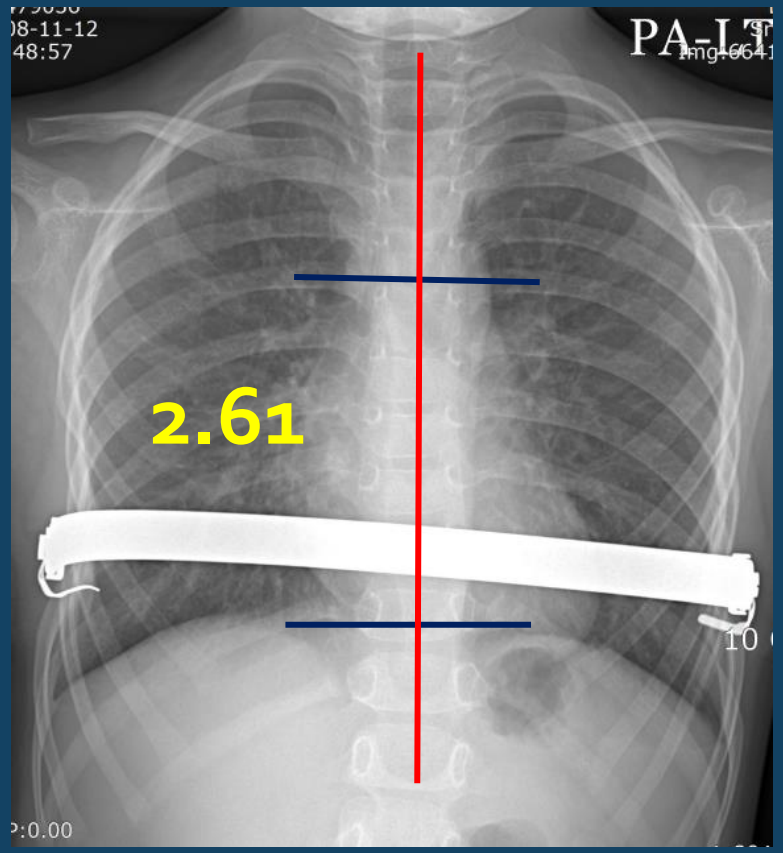
	Mild Scoliosis (CA<15)	Severe scoliosis (CA>15)	Combined	P value
N	28	6	34	
Decrease in				
Haller index	1.62	3.63	1.98	0.542
Sternal tilt degree	5.59	4.28	5.36	0.651
Cobb angle	3.19	-4.58	1.82	<0.001

Change in scoliosis

Mild scoliosis (Cobb angle < 15)

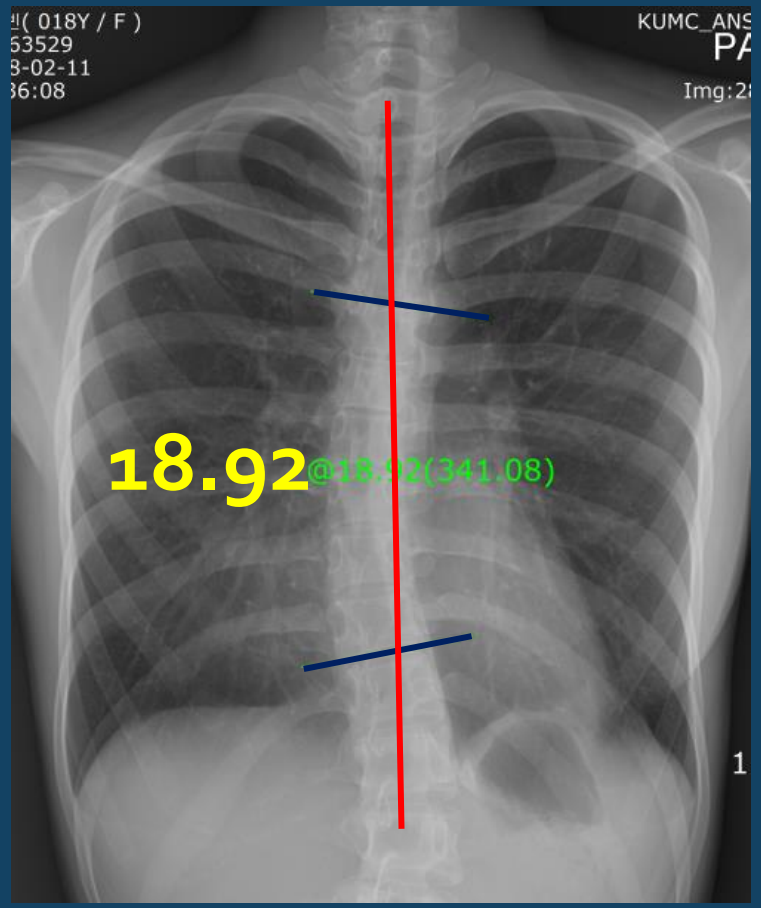


Preop.

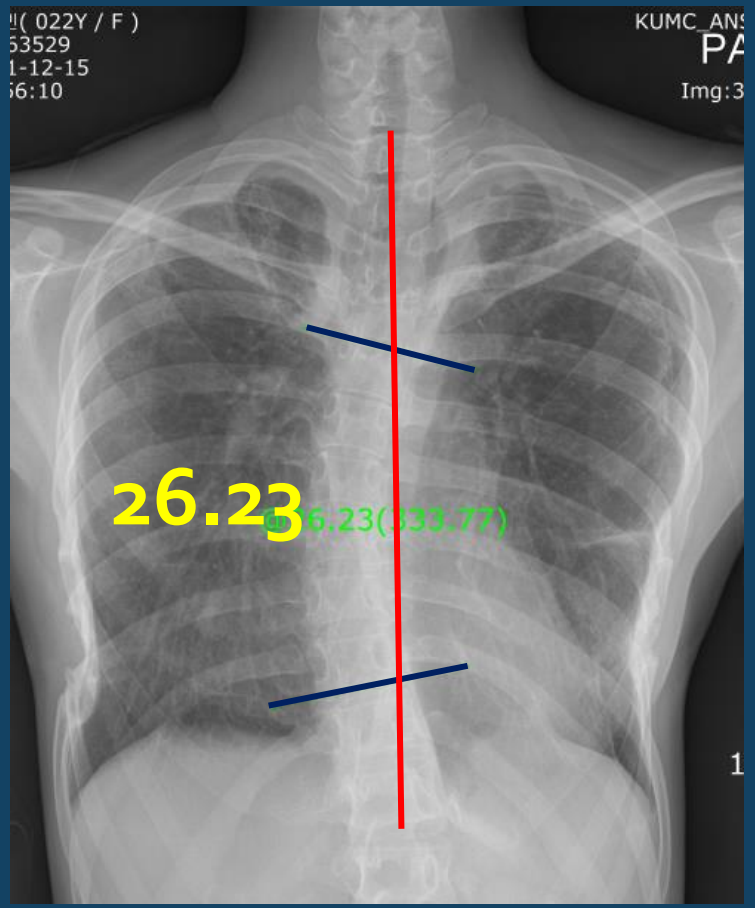


Postop.

Severe scoliosis (Cobb angle < 15)



Preop.



Postop.

Limitations

- Retrospective study
- Small number preliminary study

Conclusion

- Pectus excavatum repair using a pectus bar may improve scoliosis in mild scoliosis patients.
- However, when preoperative Cobb angle is over 15° , scoliosis may aggrevate.
- Pectus excavatum with concomitant severe scoliosis may need extra-caution in repair.
- Further investigation on how chest cage remodeling influence the spine dynamics is warranted.

A case of successful surgical repair for pectus arcuatum using chondrosternoplasty

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Introduction

Pectus arcuatum is a rare complex chest wall deformity presenting with various curvature, which make it difficult to repair. We demonstrated a case of successful surgical repair for pectus arcuatum using chondrosternoplasty.

Case presentation

A 31 year-old female presented with severely protruding upper sternum combined with concaved lower sternum. Her father has a same chest wall deformity. Echocardiogram revealed that right ventricle was compressed by anterior chest wall. Pulmonary artery was enlarged on chest CT scans.

We planned modified Ravitch type operation instead of minimally invasive repair technique. A vertical mid-sternal incision was made. After dissecting under bilateral pectoralis major muscles, chondrectomies were accomplished from 2^{nd} to 5^{th} costal cartilages saving perichondrium.

And we performed first horizontal osteotomy in wedge shape on the most protruding point, angle of Louis. In order to un-bend the lower sternal body, we put an additional partial osteotomy at the most concaved point. Resected wedge-shape bone fragment obtained from the first osteotomy was minced to small pieces and re-implanted to lower osteotomy site. Osteotomized sternum was fixed with multiple wirings to prevent horizontal displacement.

She was dismissed without complication on postoperative 6^{th} day. No adjuvant external compression device was used. External morphology of the chest wall has been stabilized more satisfactory after 6 months of remodeling period (Figure 1).

Conclusion

Pectus arcuatum deformity was considered as quite difficult to correct. However; combining conventional chest wall repair technique and its modification can be useful in an adult who has rigid skeletal structure.

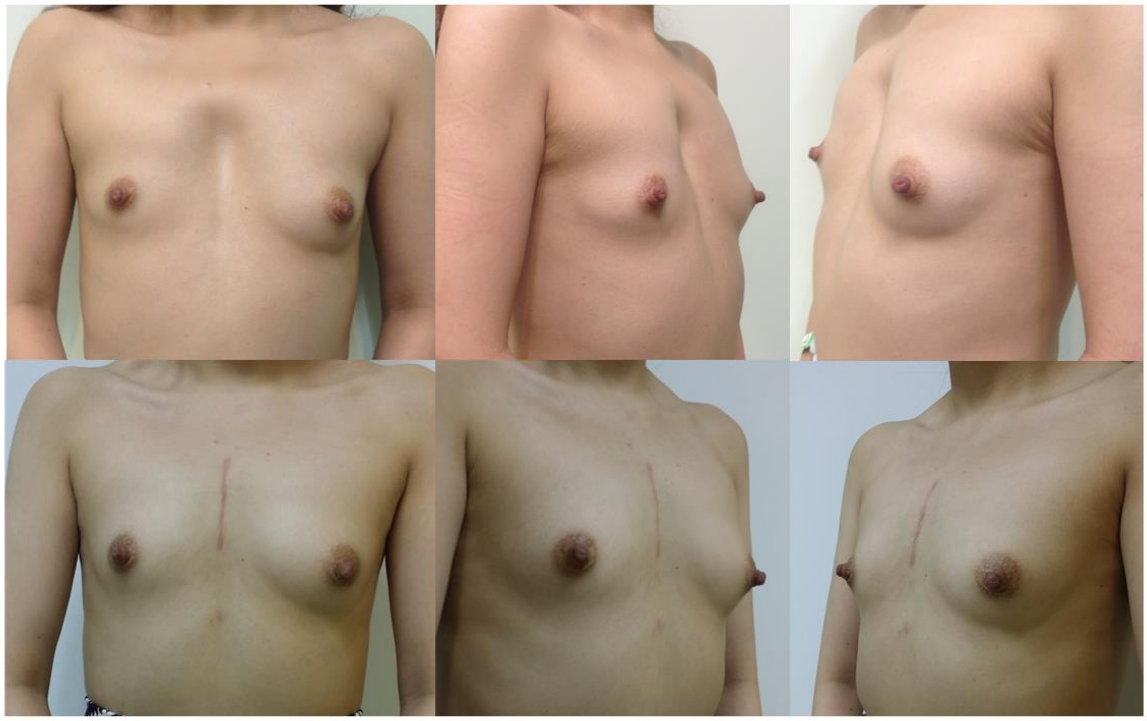

Figure 1. 1st row ; preoperative photographs, 2nd row; postoperative 6th months photographs

The Factors Affecting the Patient Compliance in Compressive Brace Therapy for Pectus Carinatum

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Chief, Department of Thoracic Surgery
Yonsei university College of Medicine, Gangnam Severance Hospital

Objective: The aim of this study was to analyze the factors affecting patient compliance in the bracing treatment for pectus carinatum patients.

Materials and Methods: 86 patients from August, 2008 to November, 2011 were included in this study. According to period of brace wear, the patients were divided into two groups: patients who wore the brace more than 6 months (compliance group) and patients who wore less than 6 months (noncompliance group). The factors affecting patient compliance was assessed at the last follow-up day with a questionnaire in multiple-choice questions. The question about the factors affecting patient compliance was composed of seven items: pain on compressive area, skin problems on compressive area, confidence in brace treatment, shame, discomfort, initial result of bracing treatment and total numbers of factors affecting patient compliance.

Results: Patient characteristics were summarized in table 1. 86 patients were completed the survey and there were 7 (8.1%) females and 79 (91.9%) male with a mean age of 12.0 years at the time of treatment (range, 3 - 20 years). Initial result of compression period (p<0.001) and total numbers of factors affecting patient compliance (p<0.05) were the predictors affecting patient compliance.

Conclusions: Initial good result of compression period may be increase the patient compliance and the effort to decrease pain, skin problems, shame, discomfort, and to give confidence in bracing treatment may also be needed.

Pectus Carinatum Repair

The Press & Mold

Hyung Joo Park, MD
Seoul St. Mary's Hospital, Seoul, Korea

1. Press-Molding

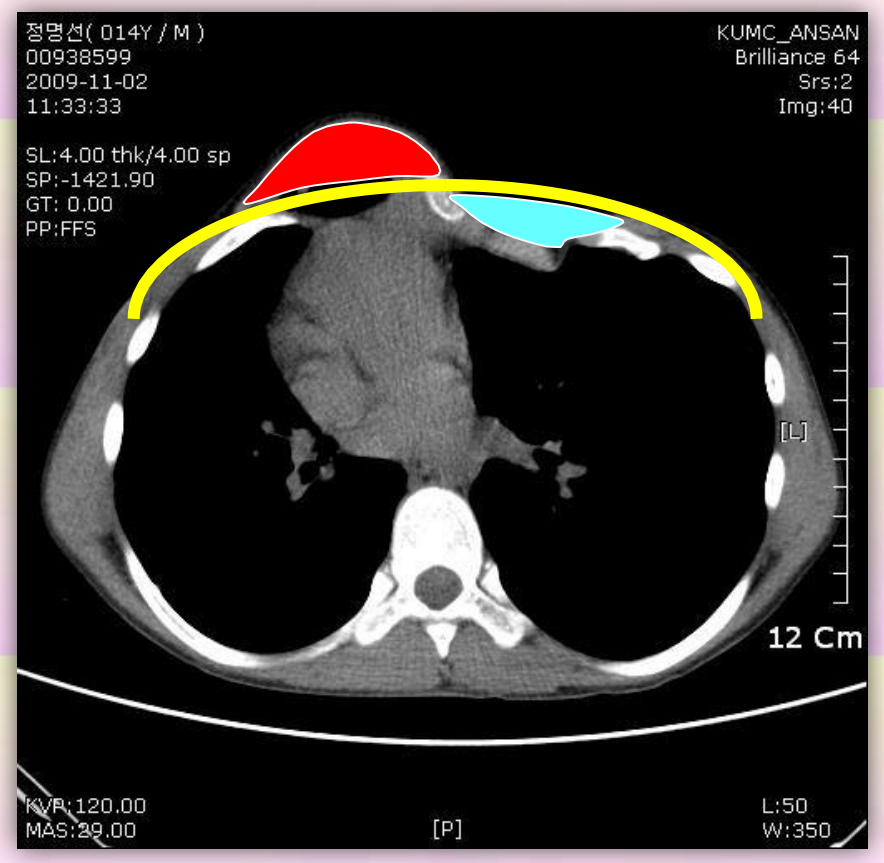
2. Flare-buster

3. Magic String

Indications

- Pectus Carinatum
- Asymmetric Complex PC
- PE + PC Complex
- Flare buster
- Residual Focal Protrusion

PRINCIPLE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Img:40
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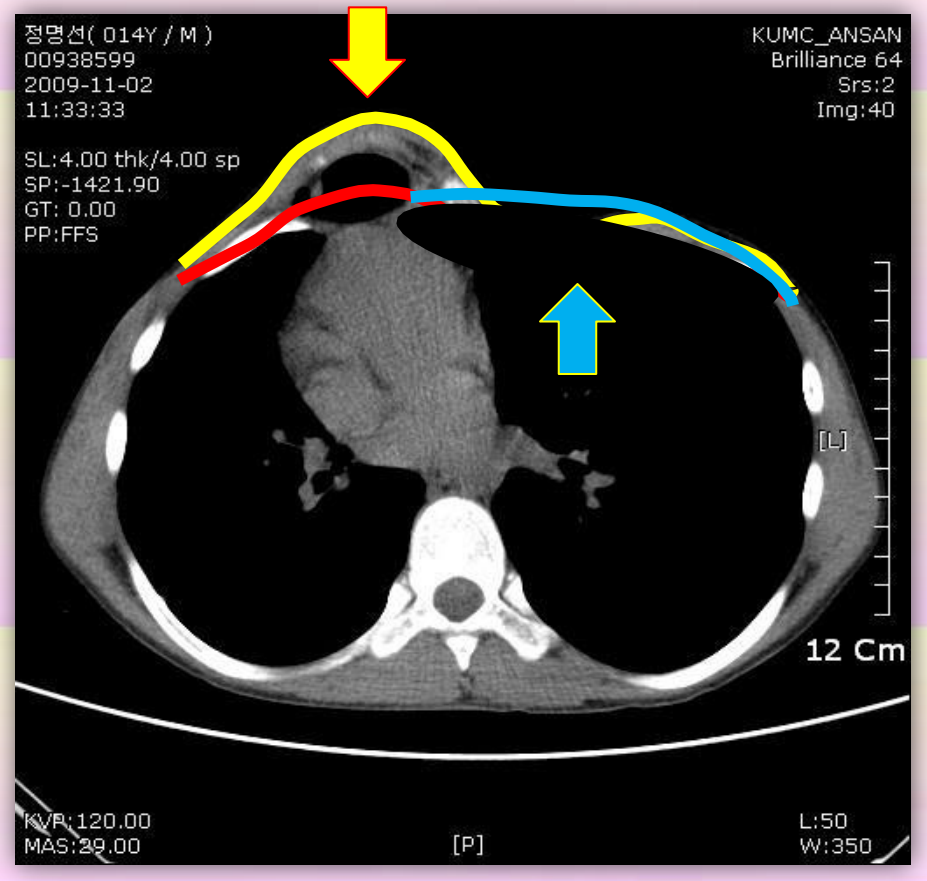
REPAIR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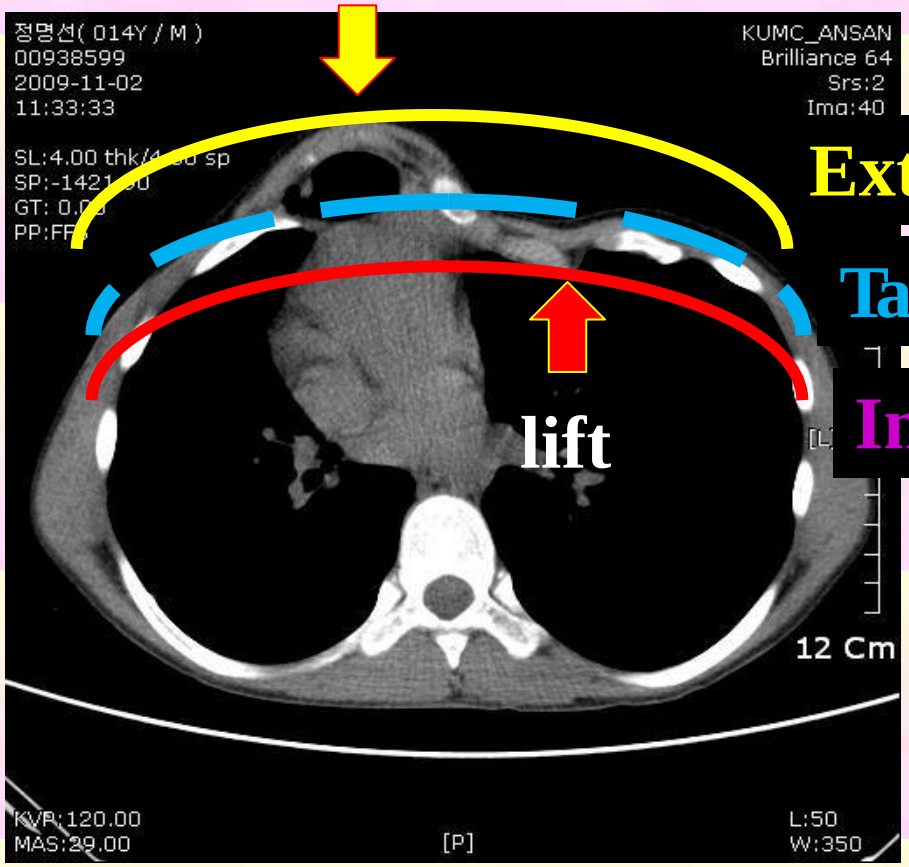
PRESS-MOLDING

compression



External Bar

Target Level

Internal Bar

Material

Pectus Carinatum:

2009 -

N=32

Age= 12Y (5-22)

1999-2015

P=2,482 + PBR=1,639

Total: 4,122

Press-Mold
“Waffle Iron Technique”

The Flare-buster

Hyung Joo Park, MD.
Seoul, Korea

Flare-buster

- 2011, Park, Korea, N=86
- String Compression on the Lower Costal Flare
- o Double Strand PDS
- #5 Ethibond
- Press-Molding

Background

- Lower Costal Flare

  - No Physiological Significance

  - Cause of Less Satisfaction

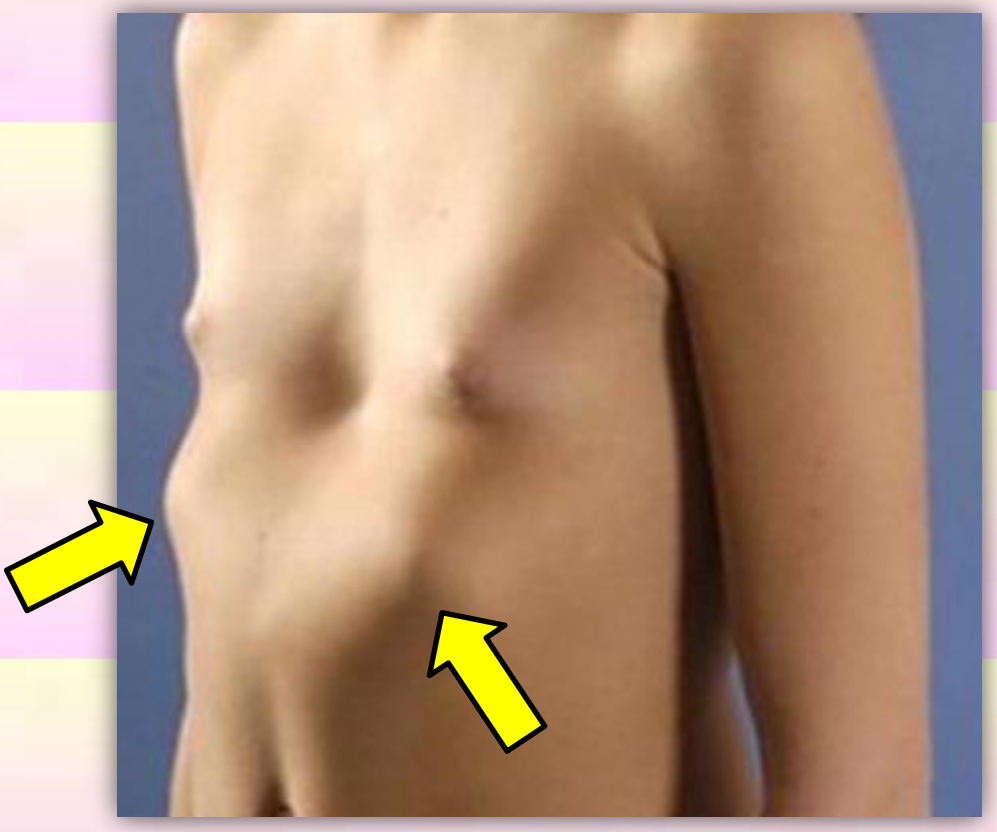
  - Not Solved for 15 Years

Technique for Flare-buster

- String Compression on the Lower Costal Flare
- o Double Strand PDS
- #5 Ethibond, #2 Polysorb x 2
- Press-Molding

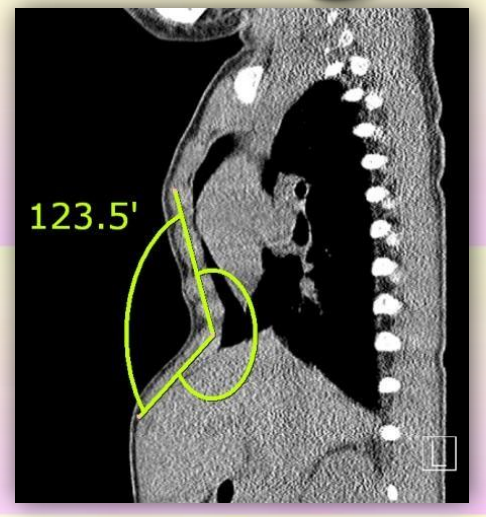
A New Technique Since 2012

Flare



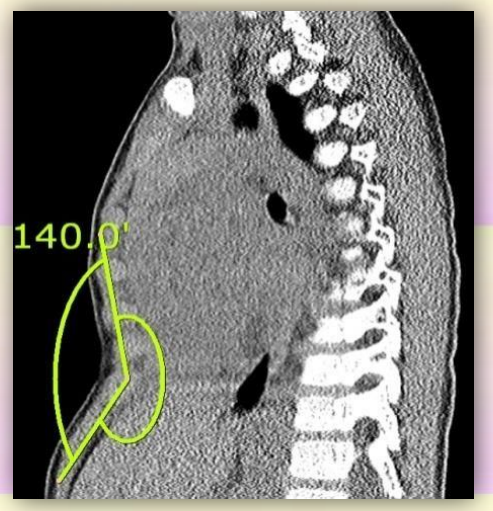
Flare Angle Measuring

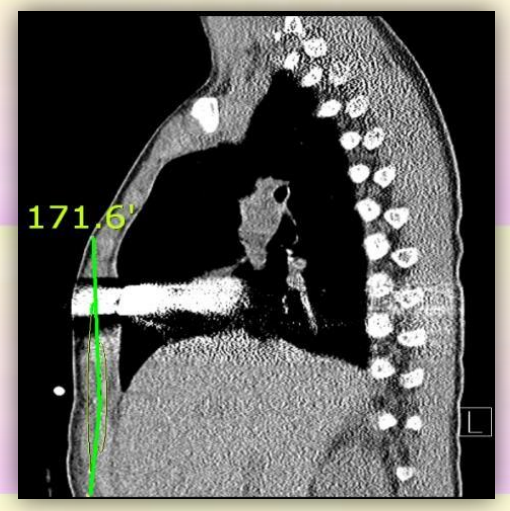
Conventional



P>0.05

Flare-buster





P<0.01

Pre

Post

The Magic String

Hyung Joo Park, MD.
Seoul, Korea

The Magic String

- 2012, Park, Korea
- Focal Residual Protrusions after PE Repair
- Compression with a Nylon Tape
- Press-Molding

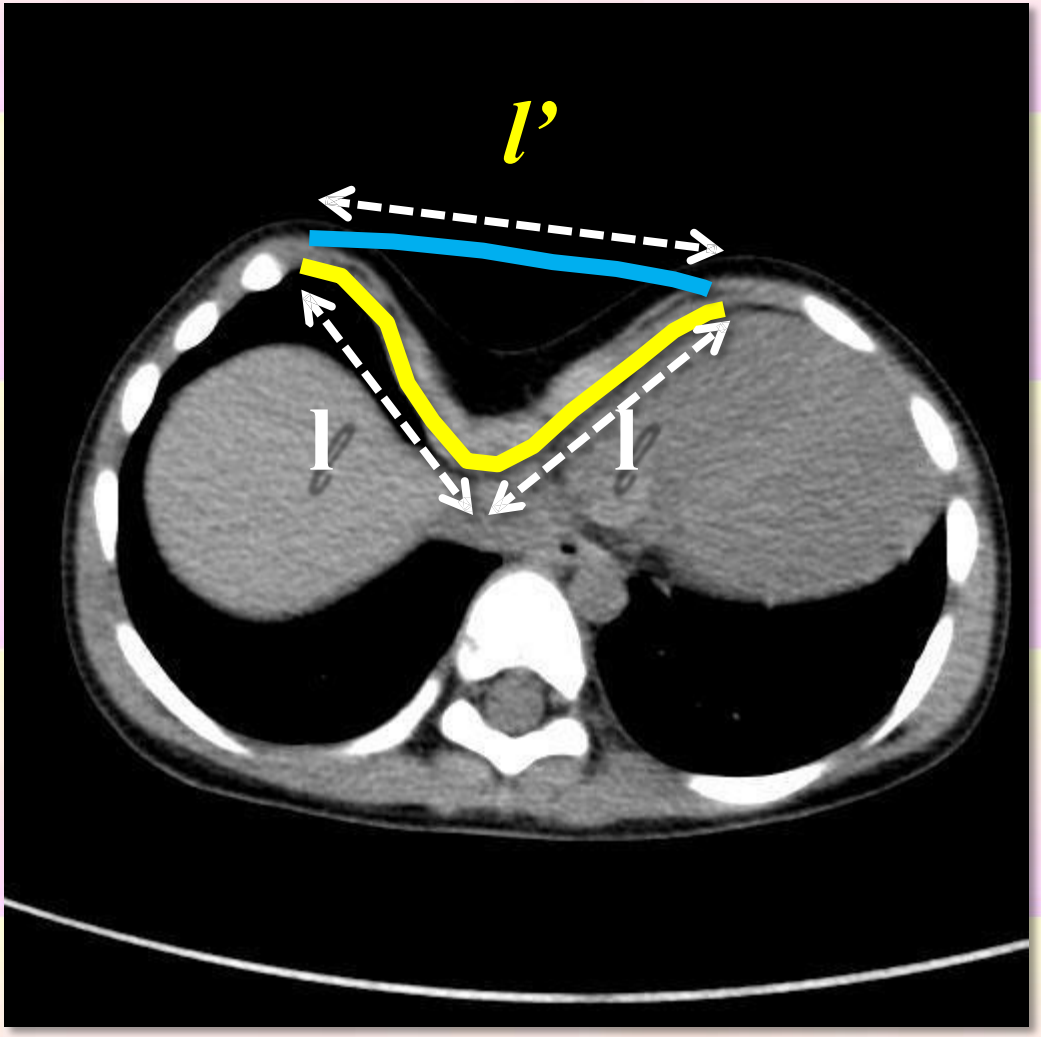
Reactive Carinatum

Hyung Joo Park, MD.
Seoul, Korea

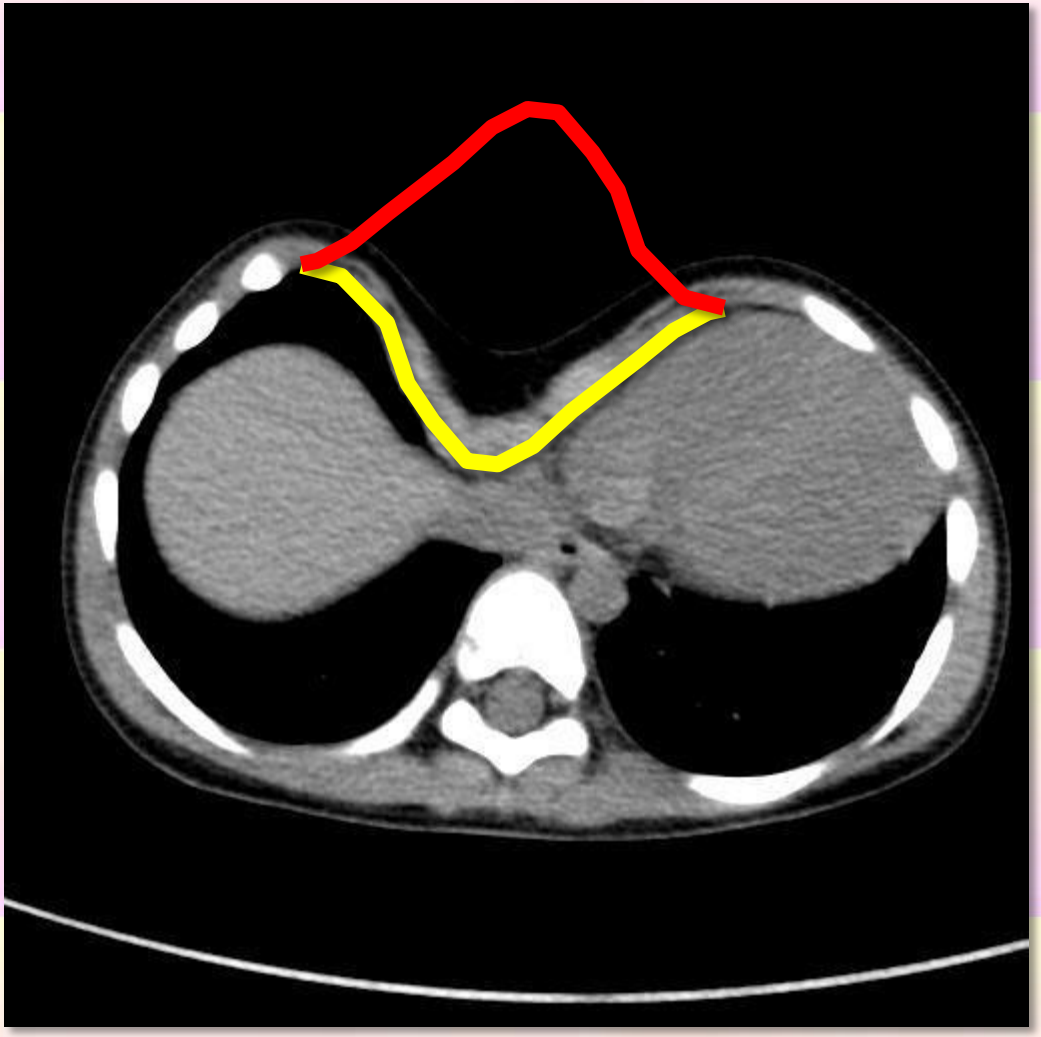
Carinatum after PE Repair

1. Extra Length Chest Wall: Severe Depression
2. Hidden Protuberance: Eccentric PE
3. Unbalanced PE
4. PE + PC Complex

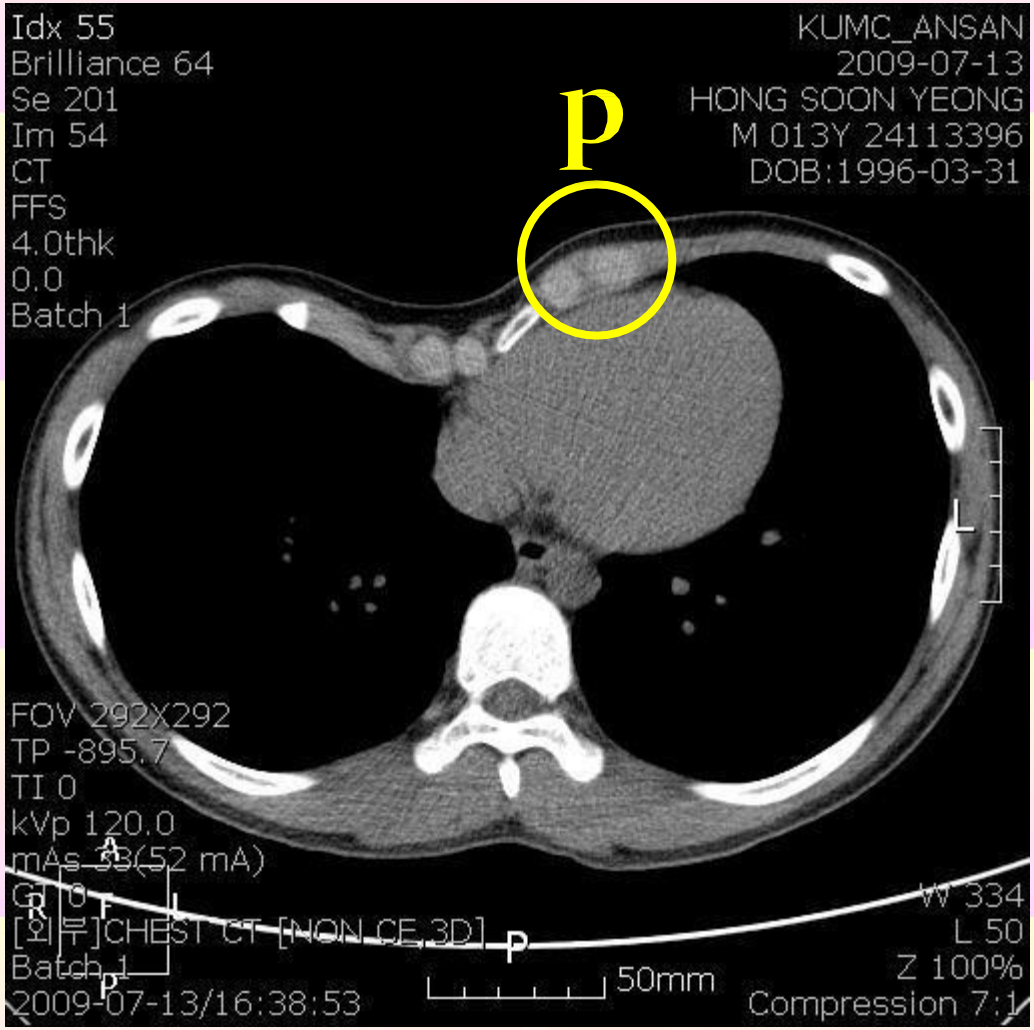
1. Extra Length Chest Wall



1. Extra Length Chest Wall



2. Hidden Protuberance



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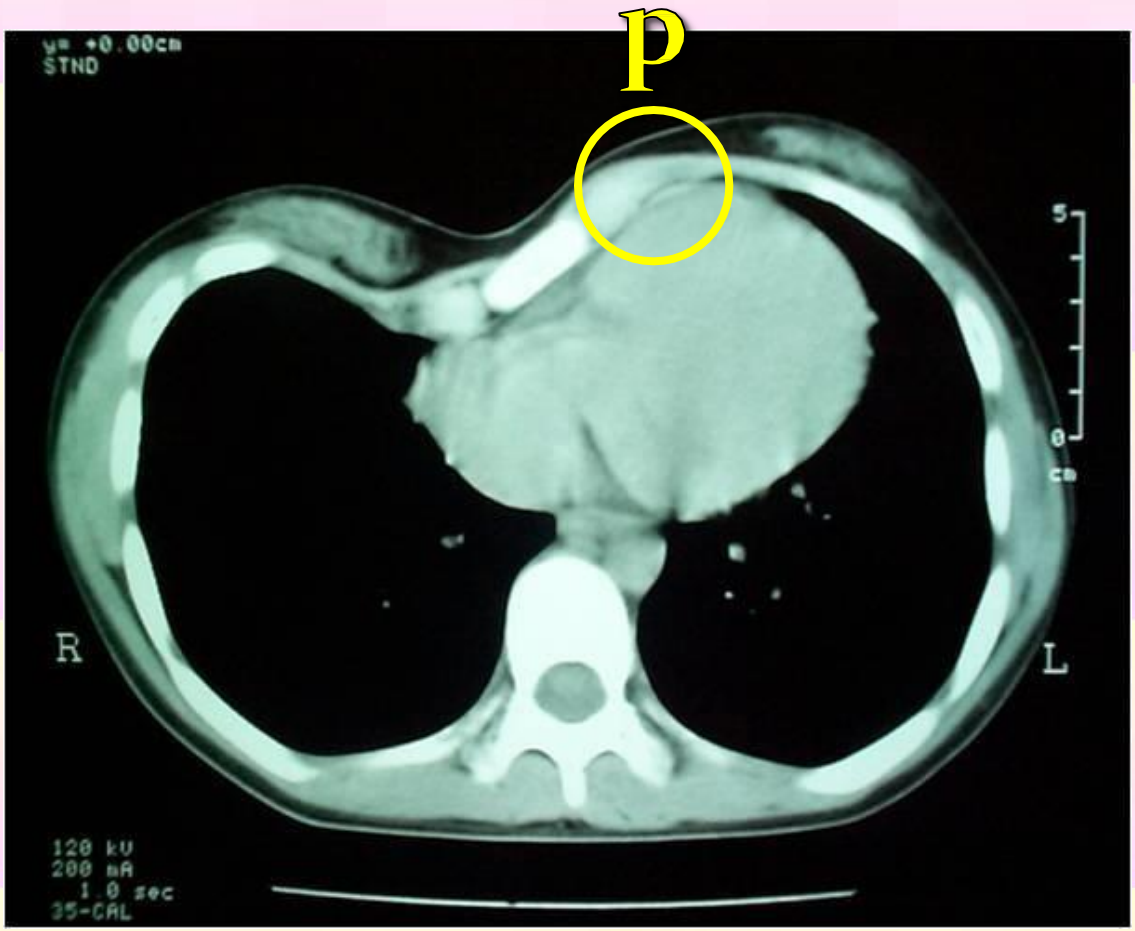
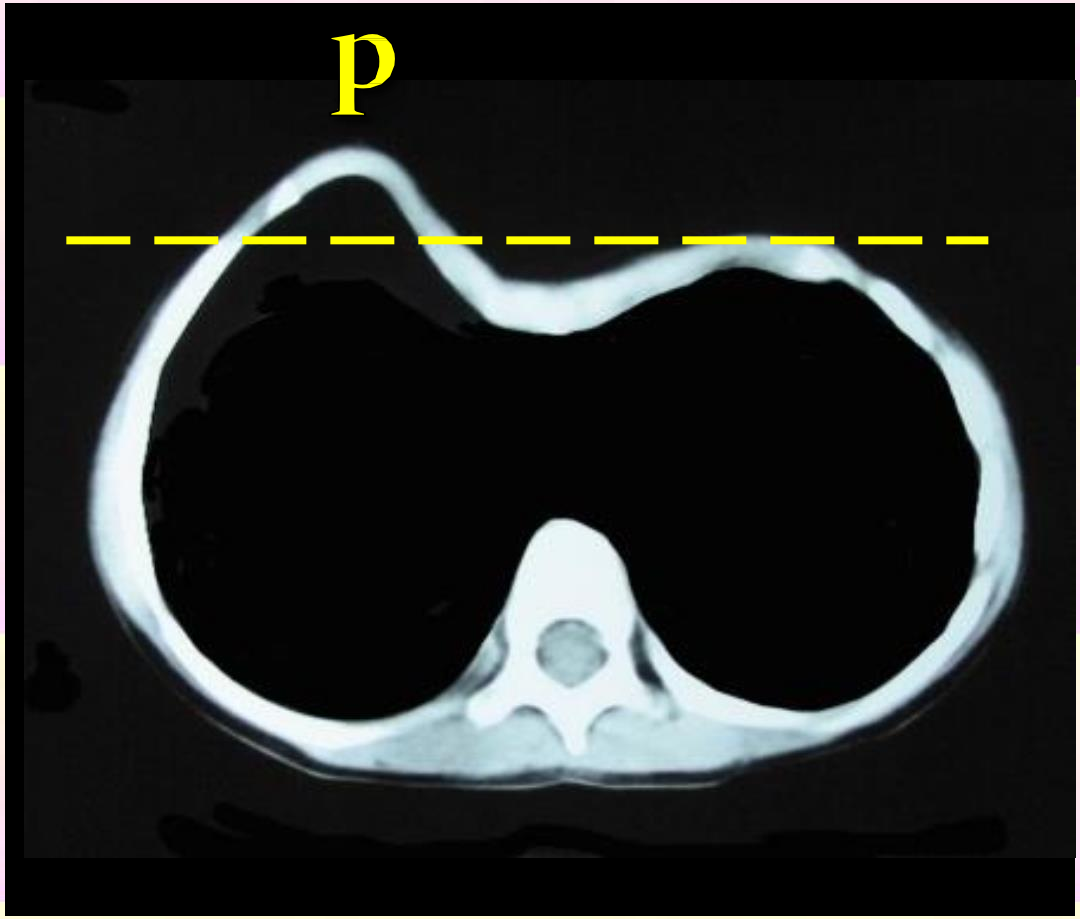
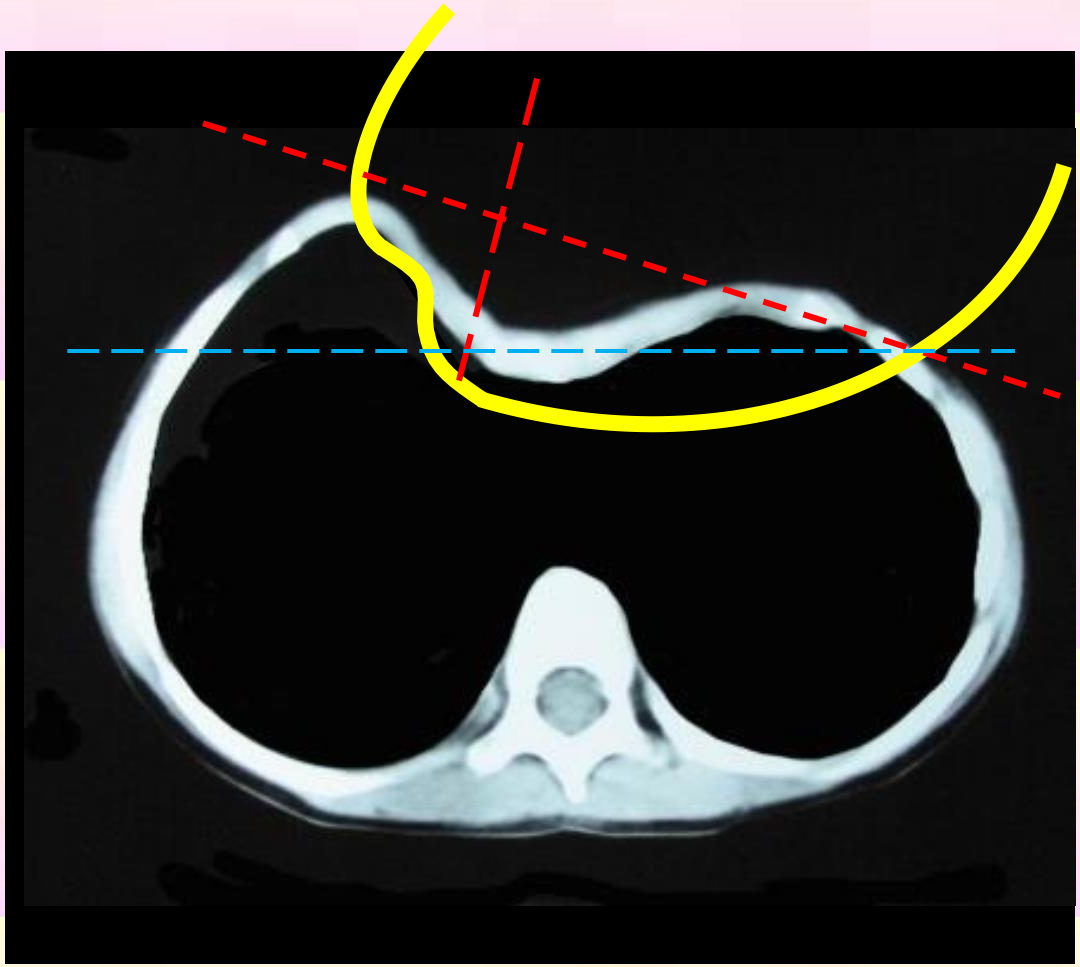


3. Unbalanced PE

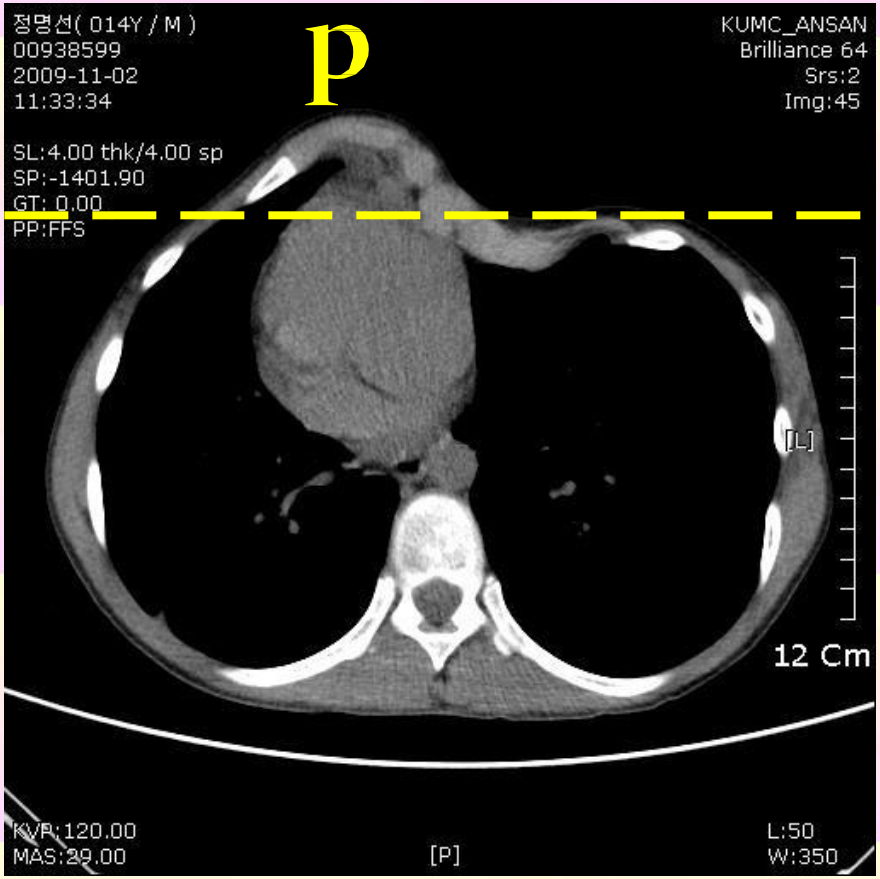


Crest Compression Technique

★ **Crest = Hinge**

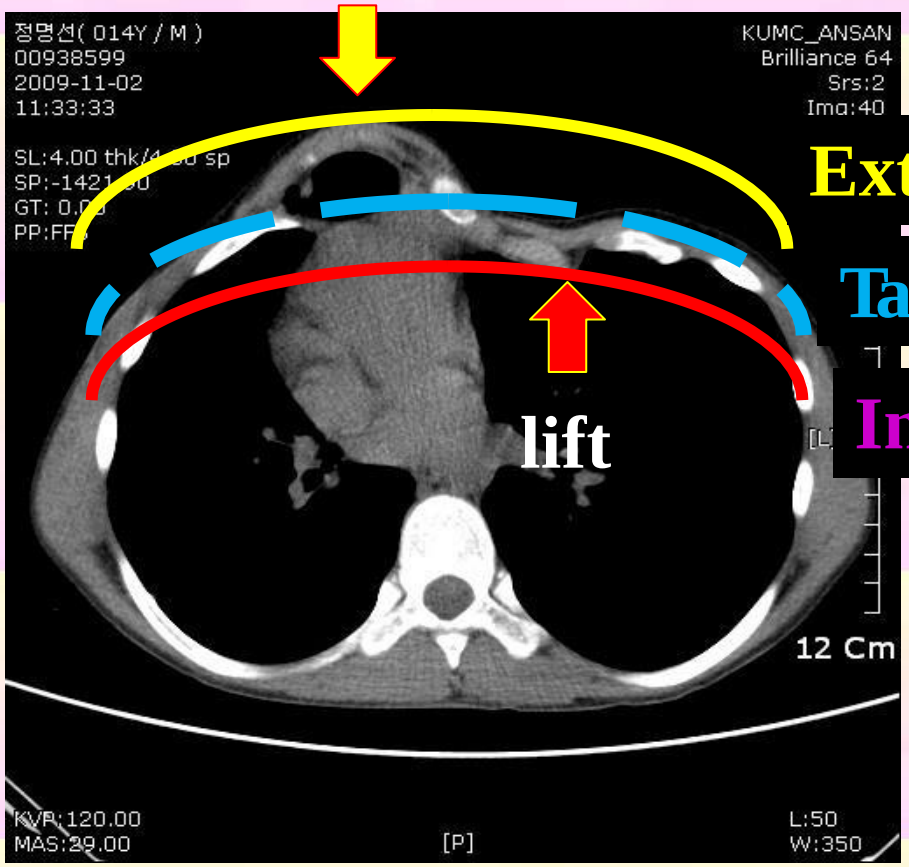


4. PE/PC Complex



SANDWICH TECH

compression



Internal Resection

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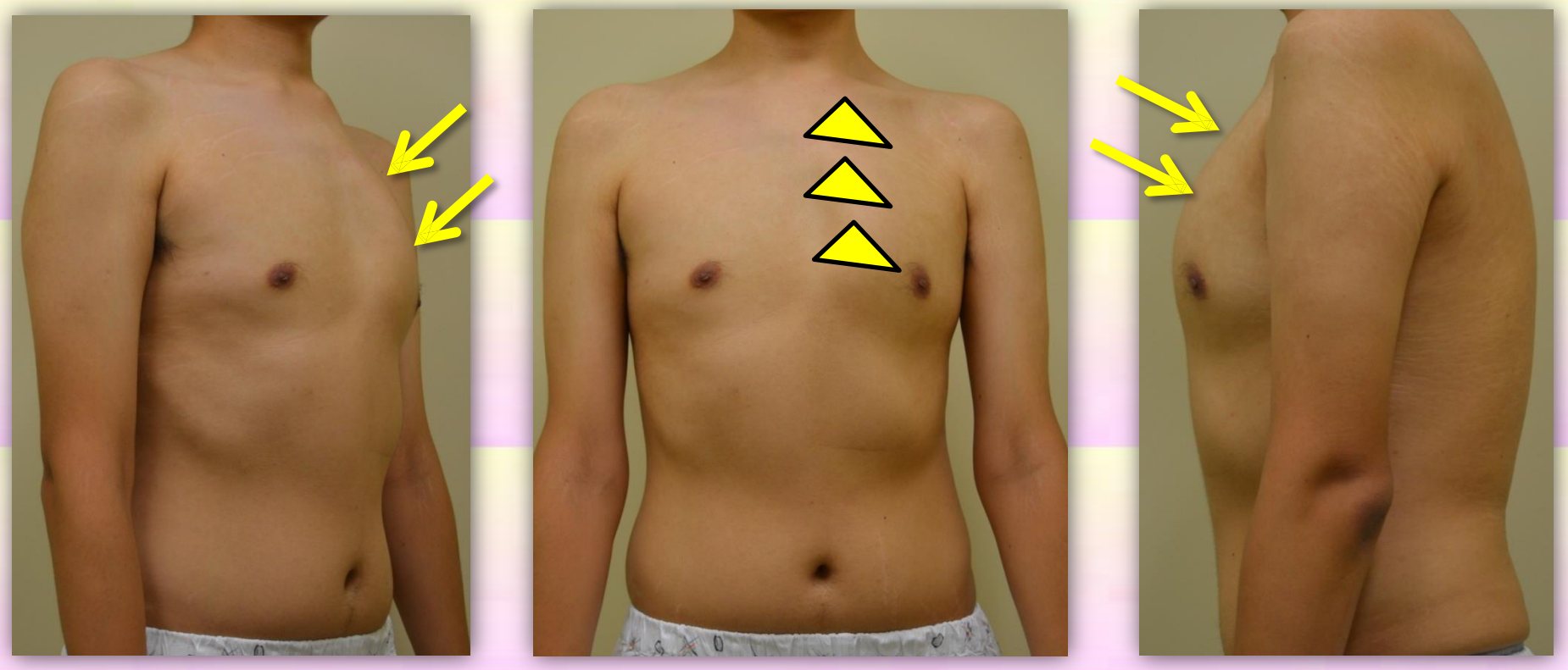
Complex Pectus Deformity

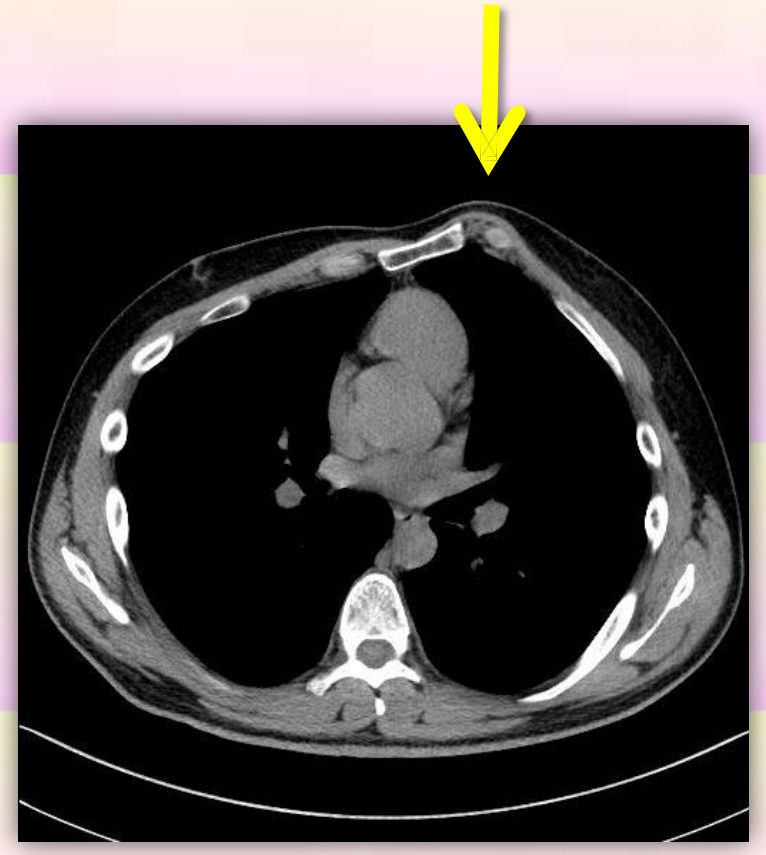
VATS
Cartilage Resection
+
Press-molding

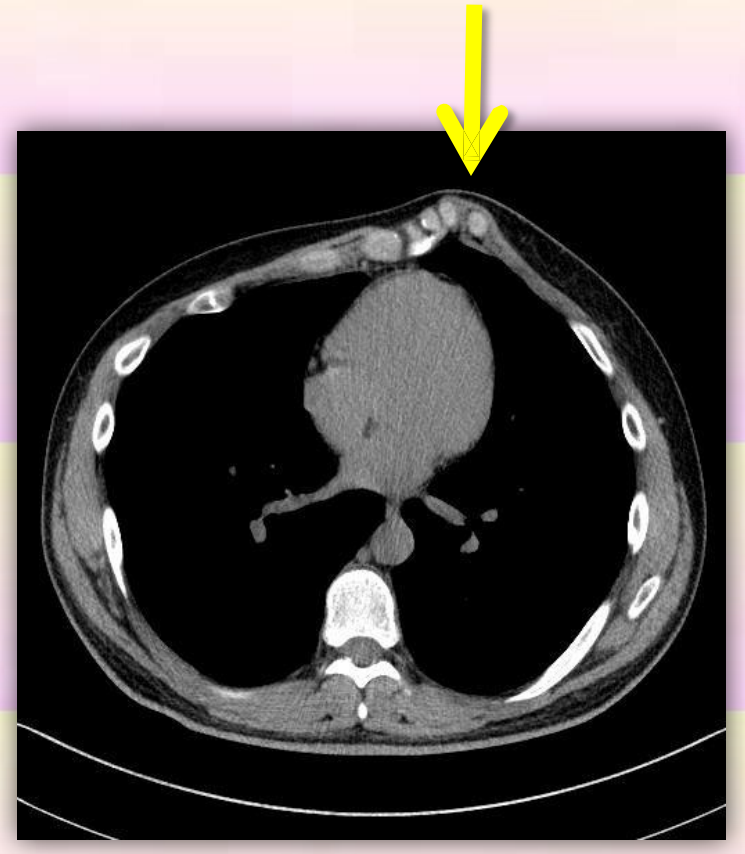
Thoracoscopic Cartilage Resection

- Severely Deformed Asymmetric Costal Cartilages Protrusions → hard to be compressed
- Focal Resection on Top
- Internal Resection
- Make it Compressible

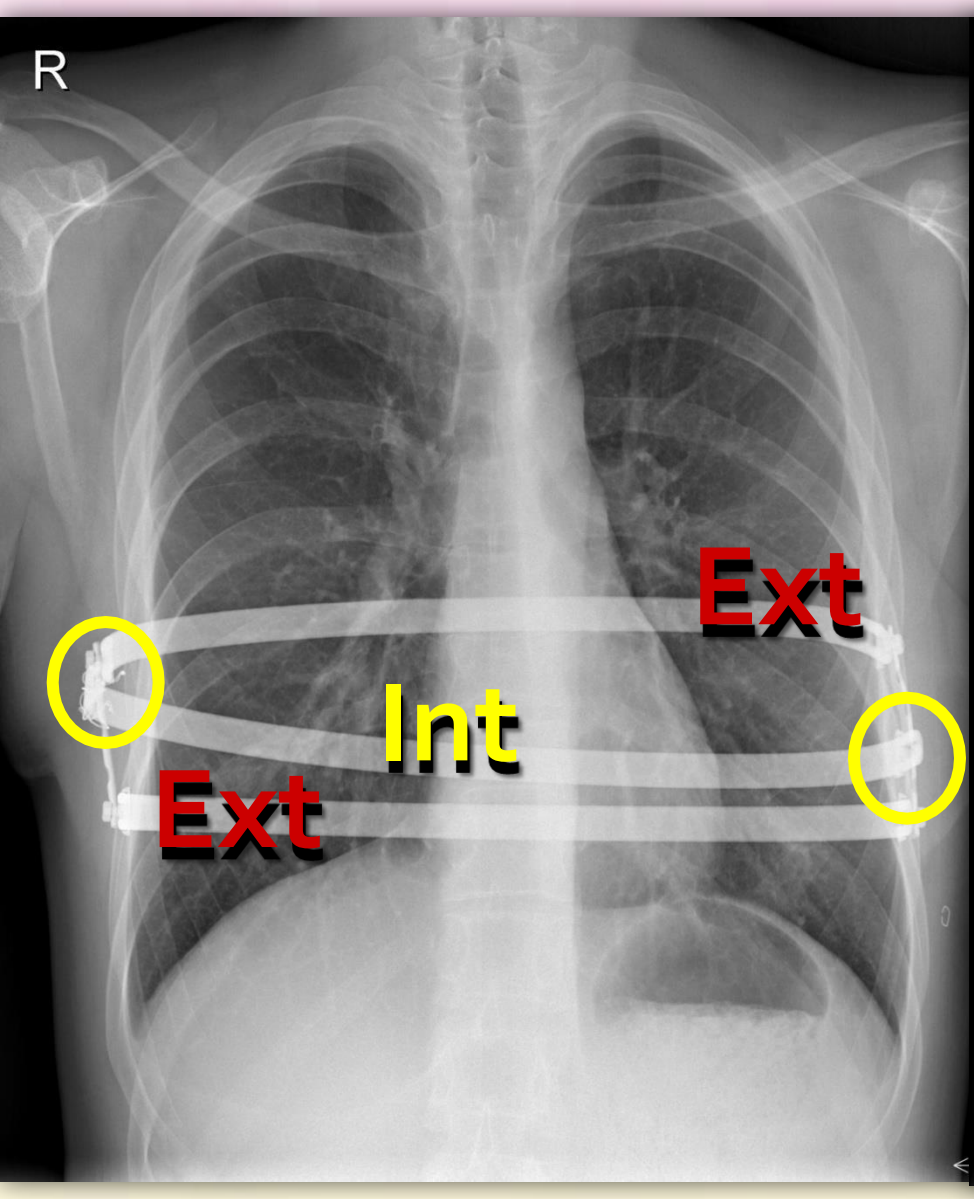
23/M, Marfan, Asym PC

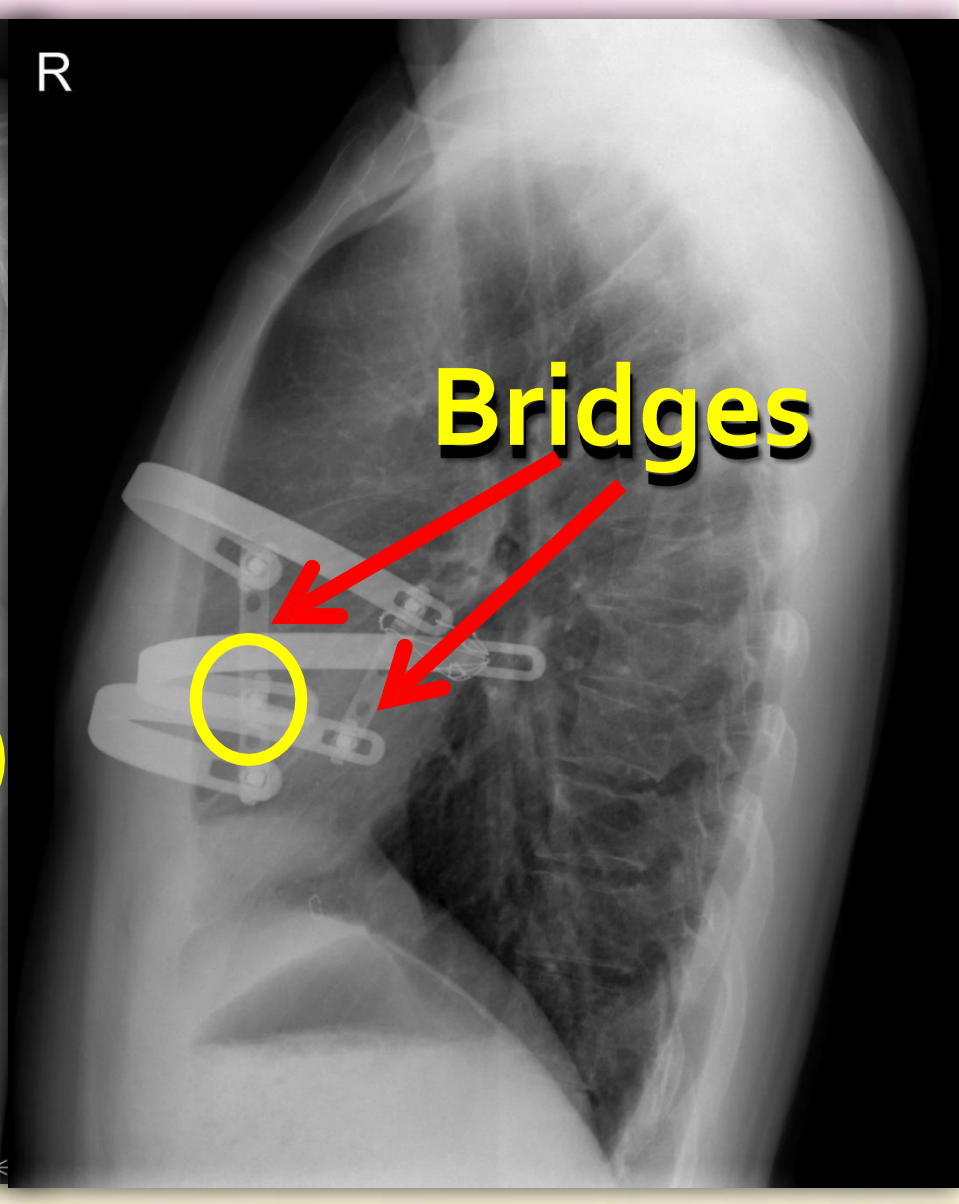






Thoracoscopic Cartilage Resection (Inernal Resection)


R
Ext
Int
Ext


R
Bridges