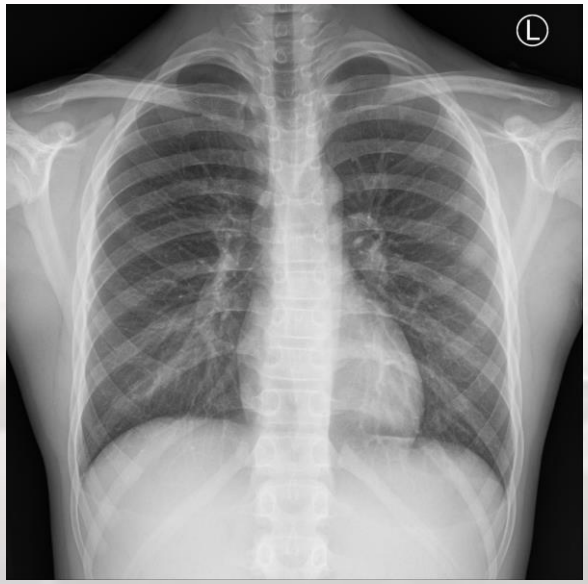
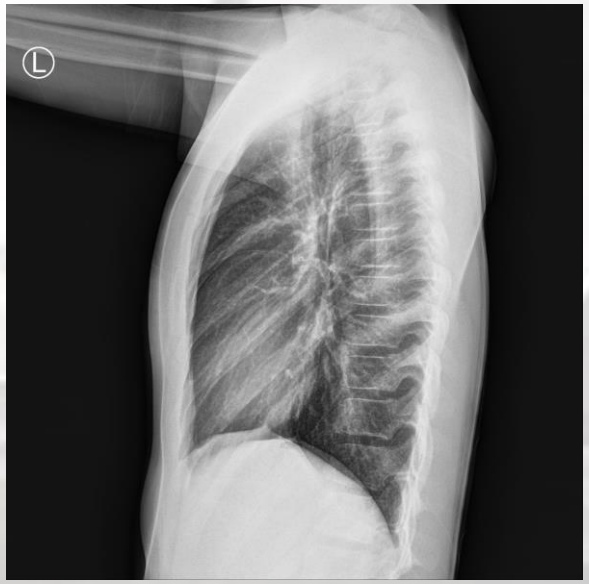
진공벨을 이용한 오목가슴의 치료효과 분석

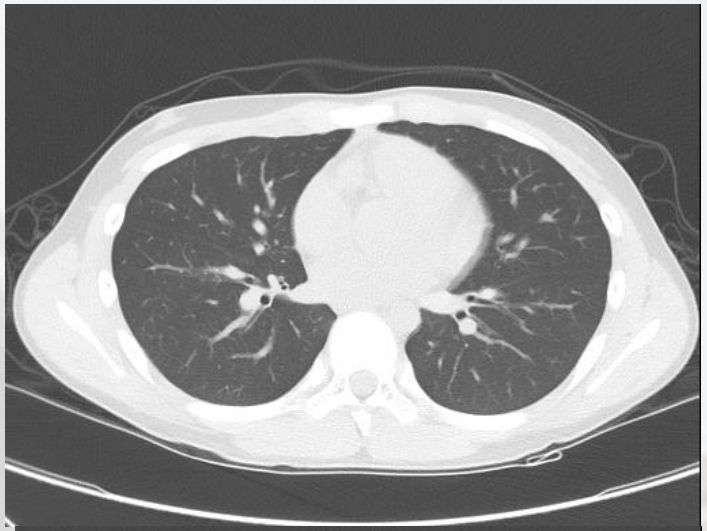
KOREA UNIVERSITY ANAM HOSPITAL
Department of Thoracic and Cardiovascular Surgery

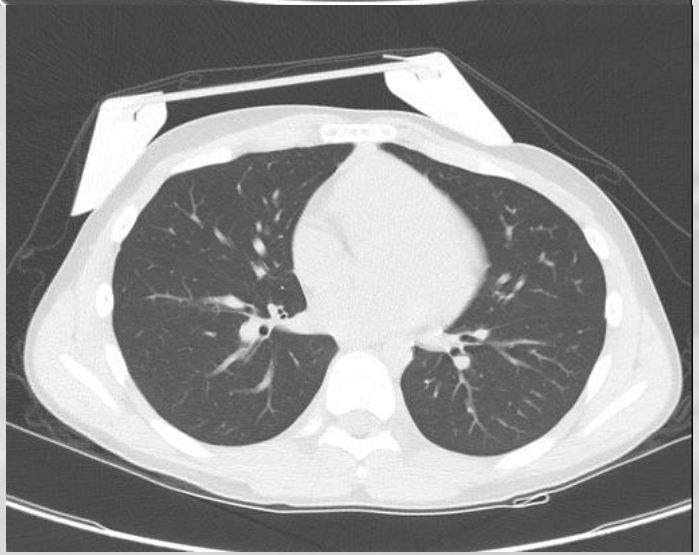
Eunjue Yi/Sungho Lee

- ***What will you do?***
  - ✓ 13 years old
  - ✓ pectus excavatum started 1year ago









History of Vacuum bell

Journal of Pediatric Surgery (2005) 40, 496–500

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Journal of Pediatric Surgery

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The vacuum chest wall lifter: an innovative, nonsurgi addition to the management of pectus excavatum

Felix Schier*, Michael Bahr, Eckard Klobe

Department of Pediatric Surgery, University Medical Centre, 55101 Mainz, Germany

100 years

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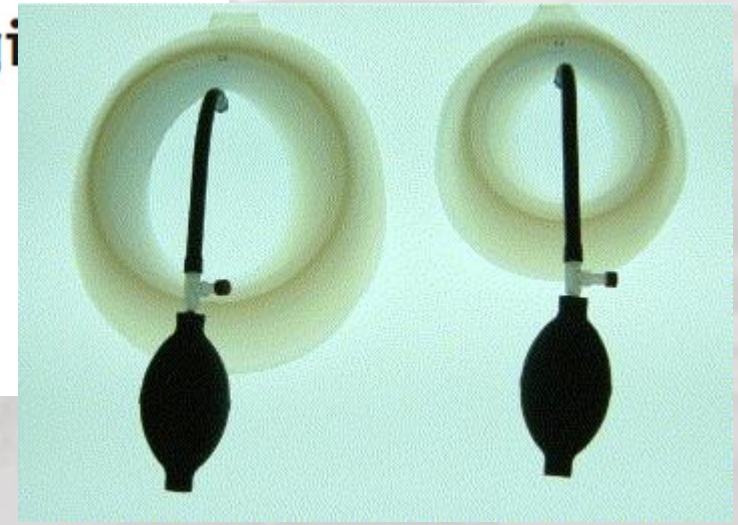
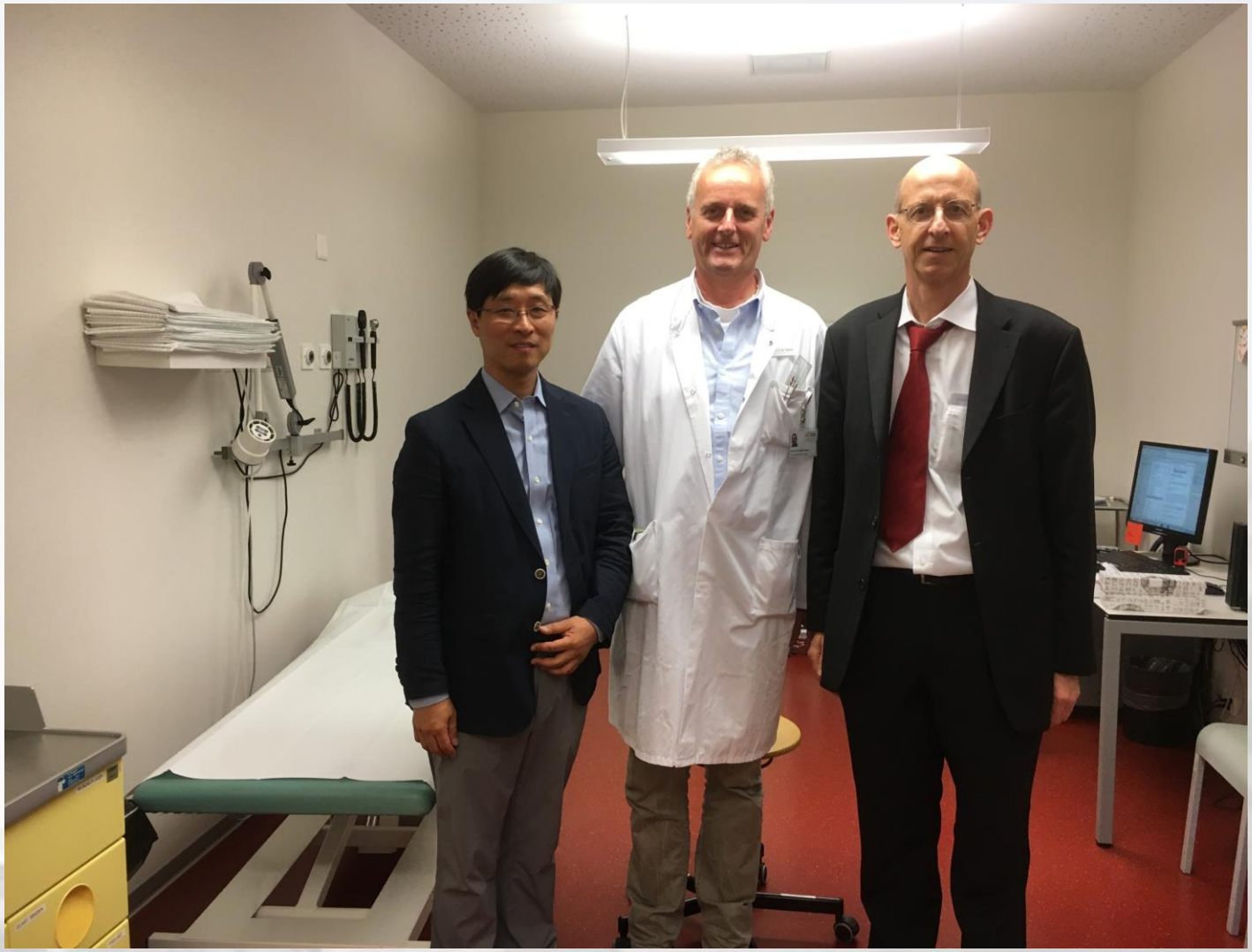


University Children's Hospital Basel.



Dr. Heacker and Klobe

Frank-Martin Haecker, MD, FEAPU

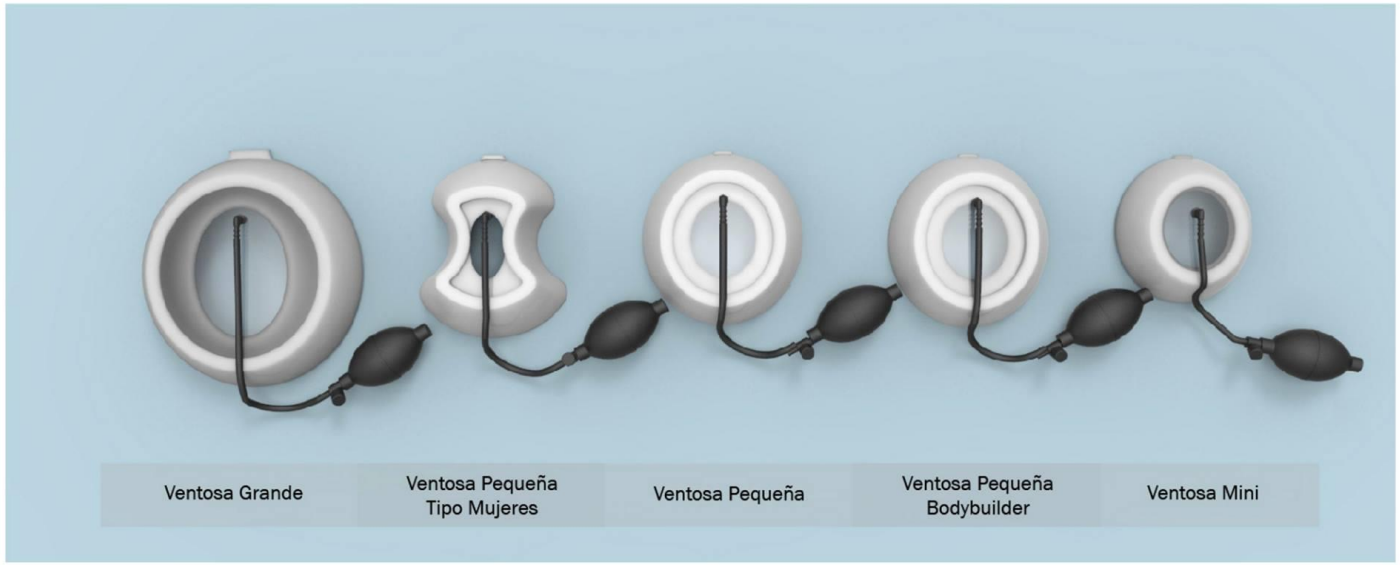
- **Children's Hospital of Eastern Switzerland, St. Gallen**

  - ✓ Department of Pediatric Surgery
  - ✓ Head of the chest wall unit, Head of the division of Pediatric urology

Types of Vacuum bell

Ventosas de Eckart Klobe®

Diseñadas para el tratamiento no-quirúrgico del pectus excavatum



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How to apply vacuum bell

Vacuum bell therapy for pectus excavatum, early experiences (1)

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Pectus Excavatums

Nonoperative management of pectus excavatum with vacuum bell therapy: A single center study

Robert J. Obermeyer [a,b,*], Nina S. Cohen [b], Robert E. Kelly Jr [a,b], M. Ann Kuhn [a,b], Frazier W. Frantz [a,b], Margaret M. McGuire [a,b], James F. Paulson [a,b,c]

[a] Children's Hospital of the King's Daughters, Norfolk, VA, USA
[b] Eastern Virginia Medical School, Norfolk, VA, USA
[c] Old Dominion University, Norfolk, VA, USA

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ABSTRACT

Purpose: The purpose of this study was to determine variables predictive of an excellent correction using vacuum bell therapy for nonoperative treatment of pectus excavatum.
Methods: A single institution, retrospective evaluation (IRB 15-01-WC-0024) of variables associated with an excellent outcome in pectus excavatum patients treated with vacuum bell therapy was performed. An excellent correction was defined as a chest wall depth equal to the mean depth of a reference group of 30 male children without pectus excavatum.
Results: Over 4 years (11/2012–11/2016) there were 180 patients enrolled with 115 available for analysis in the treatment group. The reference group had a mean chest wall depth of 0.51 cm. An excellent correction (depth ≤ 0.51 cm) was achieved in 23 (20%) patients. Patient characteristics predictive of an excellent outcome included initial age ≤ 11 years (OR = 3.3,p = .013), initial chest wall depth ≤ 1.5 cm (OR = 4.6,p = .003), and chest wall flexibility (OR = 14.8,p < .001). Patients that used the vacuum bell over 12 consecutive months were more likely to achieve an excellent correction (OR = 3.1,p = .030). Follow-up was 4 months to 4 years (median 12 months).
Conclusion: Nonoperative management of pectus excavatum with vacuum bell therapy results in an excellent correction in a small percentage of patients. Variables predictive of an excellent outcome include age ≤ 11 years, chest wall depth ≤ 1.5 cm, chest wall flexibility, and vacuum bell use over 12 consecutive months.
Type of study: Retrospective chart review.
Level of evidence: Level III treatment study.

Vacuum bell therapy for pectus excavatum, early experiences (2)

Journal of Pediatric Surgery 54 (2019) 194–199

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Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

Vacuum bell treatment of pectus excavatum: An early North American experience☆,☆☆,★

Etienne St-Louis [a,b], Jingru Miao [a], Sherif Emil [a,b], Robert Baird [a,b], Marcos Bettolli [c], Kathleen Montpetit [b], Jade Goyette [b], Jean-Martin Laberge [a,b,*]

[a] Division of Pediatric General and Thoracic Surgery, The Montreal Children's Hospital, McGill University Health Centre, Montreal, Quebec, Canada
[b] Chest Wall Anomaly Center, Shriners Hospital for Children, Montreal, Quebec, Canada
[c] Division of Pediatric Surgery, Children's Hospital of Eastern Ontario, University of Ottawa

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Vacuum bell
Chest wall

ABSTRACT

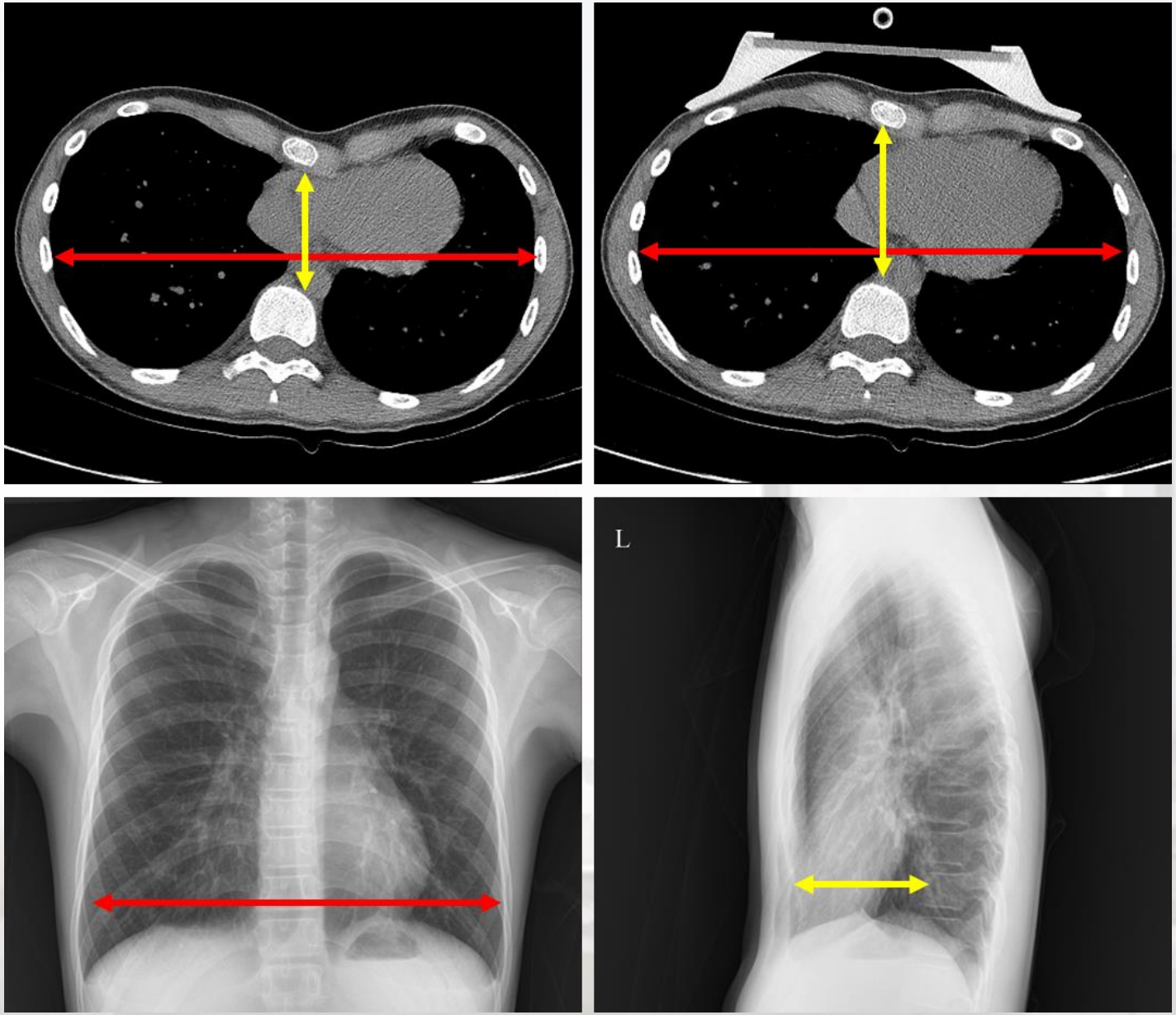
Purpose: Conservative treatment of pectus excavatum with a vacuum bell device may be an attractive alternative to surgical repair. We describe an early North American experience with this device.
Methods: Prospectively maintained chest wall clinic registries from two institutions were reviewed to identify pectus excavatum patients ≤21 years treated with the vacuum bell from 2013 to 2017. Multivariate linear regression was used to compare mean improvements in deformity-depth and Haller Index between groups of patients based on age and usage metrics (hours/day and days/week).
Results: Thirty-one patients with a median age of 14 years received treatment with the device. Mean follow-up duration was 18 months. Median depth and Haller Index at treatment onset were 2.3 cm and 3.9, respectively. Improvements in deformity-depth were superior with device usage >2 h/day ($p < 0.01$) and daily use ($p < 0.01$). After adjusting for compliance, younger age of treatment onset was associated with greater improvement in Haller Index but not deformity depth.
Conclusion: Our prospective early North American experience found the vacuum bell to be a potential alternative to surgical treatment for pectus excavatum. Longer usage periods in a daily frequency are associated with best results.
Type of study: Treatment study; case series with no comparison group.
Level of evidence: Level IV.

How could we expect appropriate treatment results from Vacuum bell device in Pectus excavatum patients

- Measurement of Expected changes

- Non-enhance chest CT
  - ✓Before and after applying vacuum bell
  - ✓Haller Index
- Sternal depths (Sternal Flexibility)
  - ✓Initial
  - ✓5-minutes after 30-minute application of VB

Expected changes in HI



Sternal Flexibility

Finding appropriate candidates for Vacuum bell therapy

Surgical versus Vacuum Bell Therapy for the Correction of Pectus Excavatum: A Comparison of 1-Year Treatment Outcomes

Younggi Jung, M.D.[1], Eunjue Yi, M.D., Ph.D.[1], Kwanghyoung Lee, M.D.[1], Jae Ho Chung, M.D., Ph.D.[1], Seonghyun Cho[2], Sungho Lee, M.D., Ph.D.[1]

[1]Department of Thoracic and Cardiovascular Surgery, Korea University Anam Hospital; [2]Korea University School of Medicine, Seoul, Korea

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Corresponding author
Sungho Lee
Tel 82-2-920-5436
Fax 82-2-920-5369
E-mail sholeemd@korea.ac.kr
ORCID
https://orcid.org/0000-0002-8882-0745

Background: The purpose of this study was to compare 1-year clinical outcomes between patients who underwent a Nuss operation or vacuum bell therapy and to present vacuum bell therapy as a possible alternative treatment modality for patients who prefer non-surgical correction of pectus excavatum.

Methods: We conducted a retrospective review of pectus excavatum patients who had undergone vacuum bell therapy for more than 1 year and examined patients who had undergone Nuss bar removal more than 1 year previously. The treatment outcomes were evaluated by comparing changes in the Haller index before and after treatment in both patient groups.

Results: We included 57 patients in this study and divided them into 2 groups according to the type of treatment received. Both groups showed no significant difference in the post-treatment Haller index after 1 year of follow-up, although the Nuss operation group showed a greater change in the Haller index than the vacuum bell group.

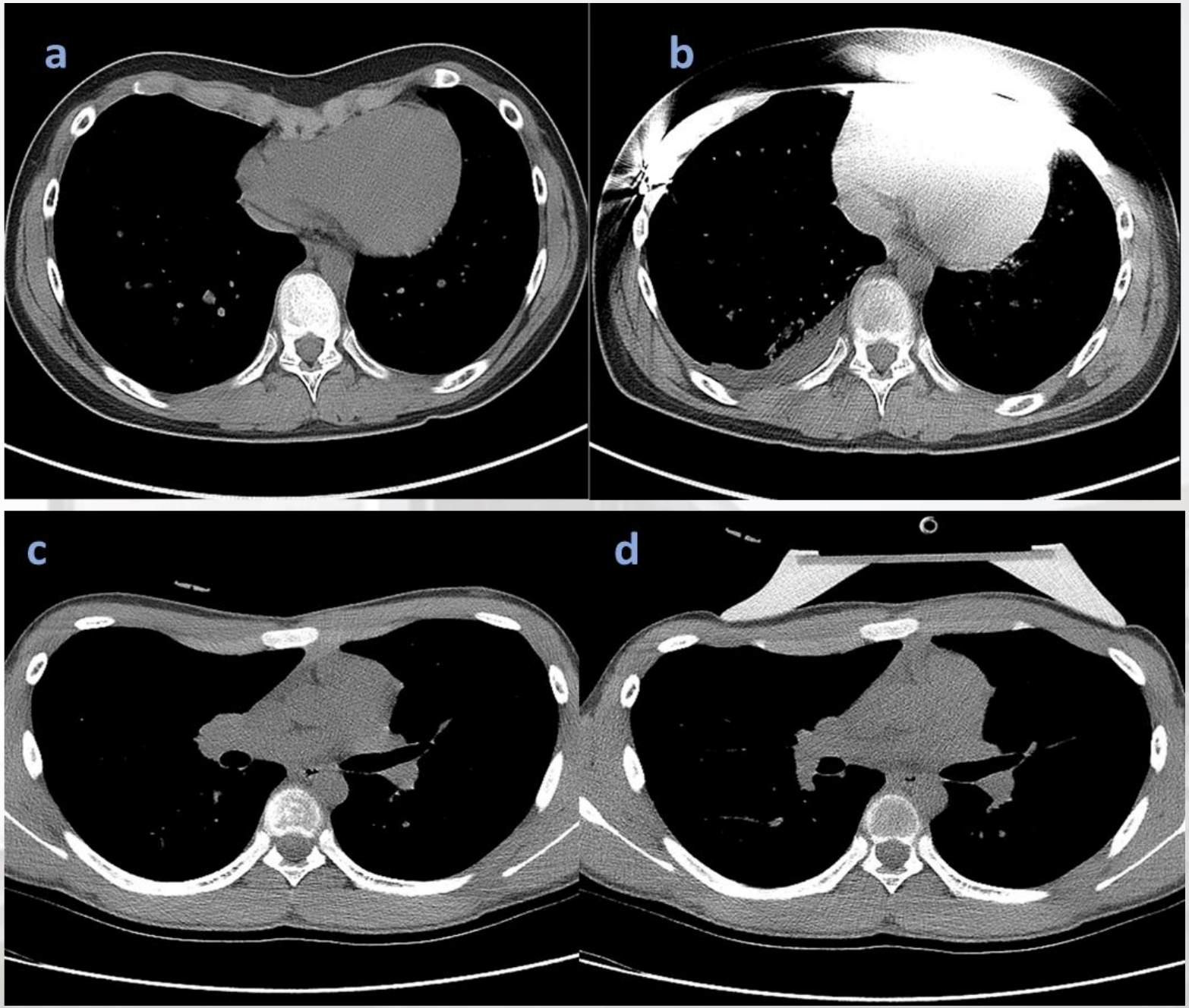
Conclusion: Although the Nuss operation is a well-established and effective treatment of choice to correct pectus excavatum, vacuum bell therapy showed comparable outcomes and could become an alternative treatment modality for select patients who prefer non-invasive treatment.

Keywords: Pectus excavatum, Vacuum bell, Outcomes

Calculating Expected changes in HI

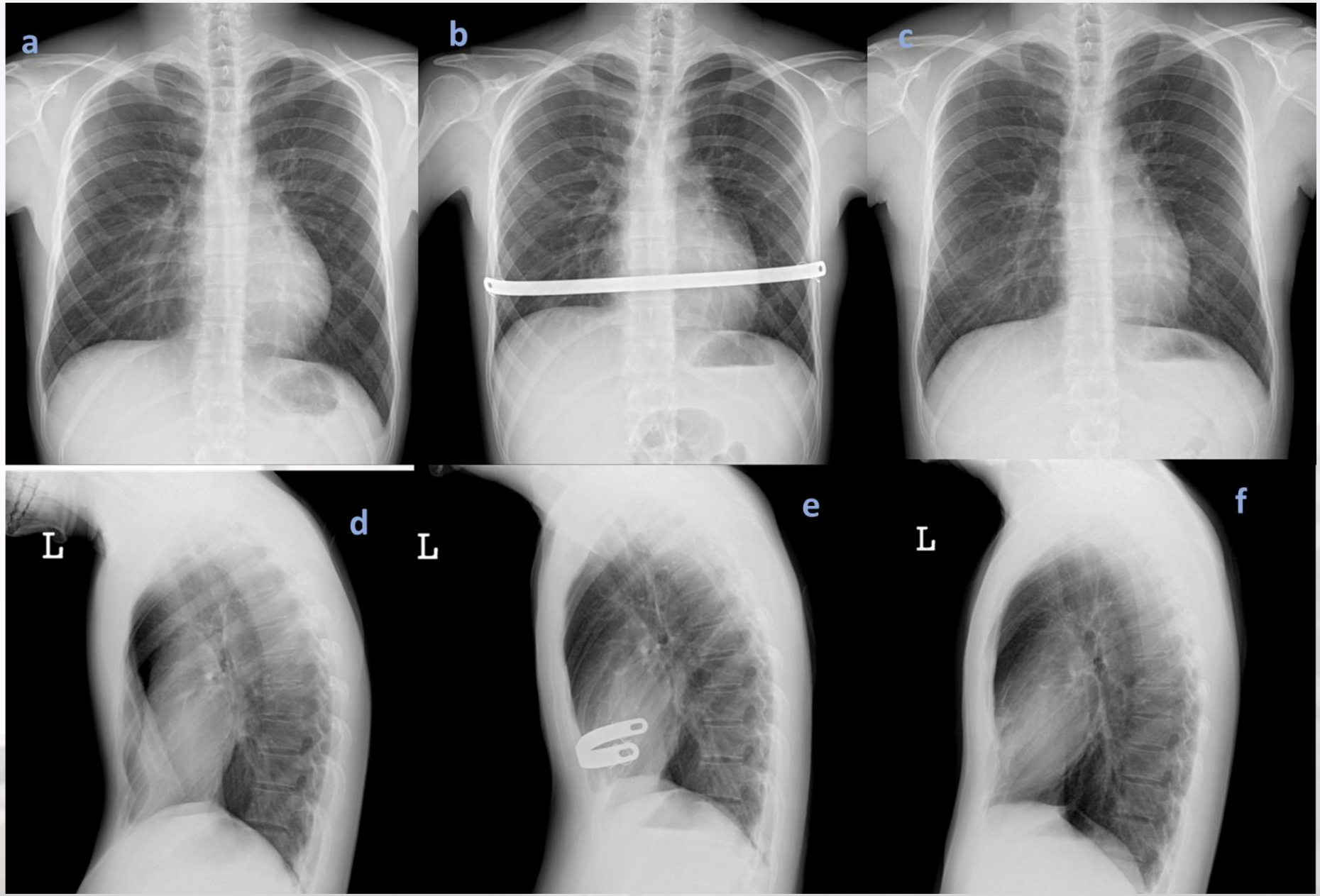
For Surgery

For Vacuum bell



Measuring treatment outcomes

For Surgery group

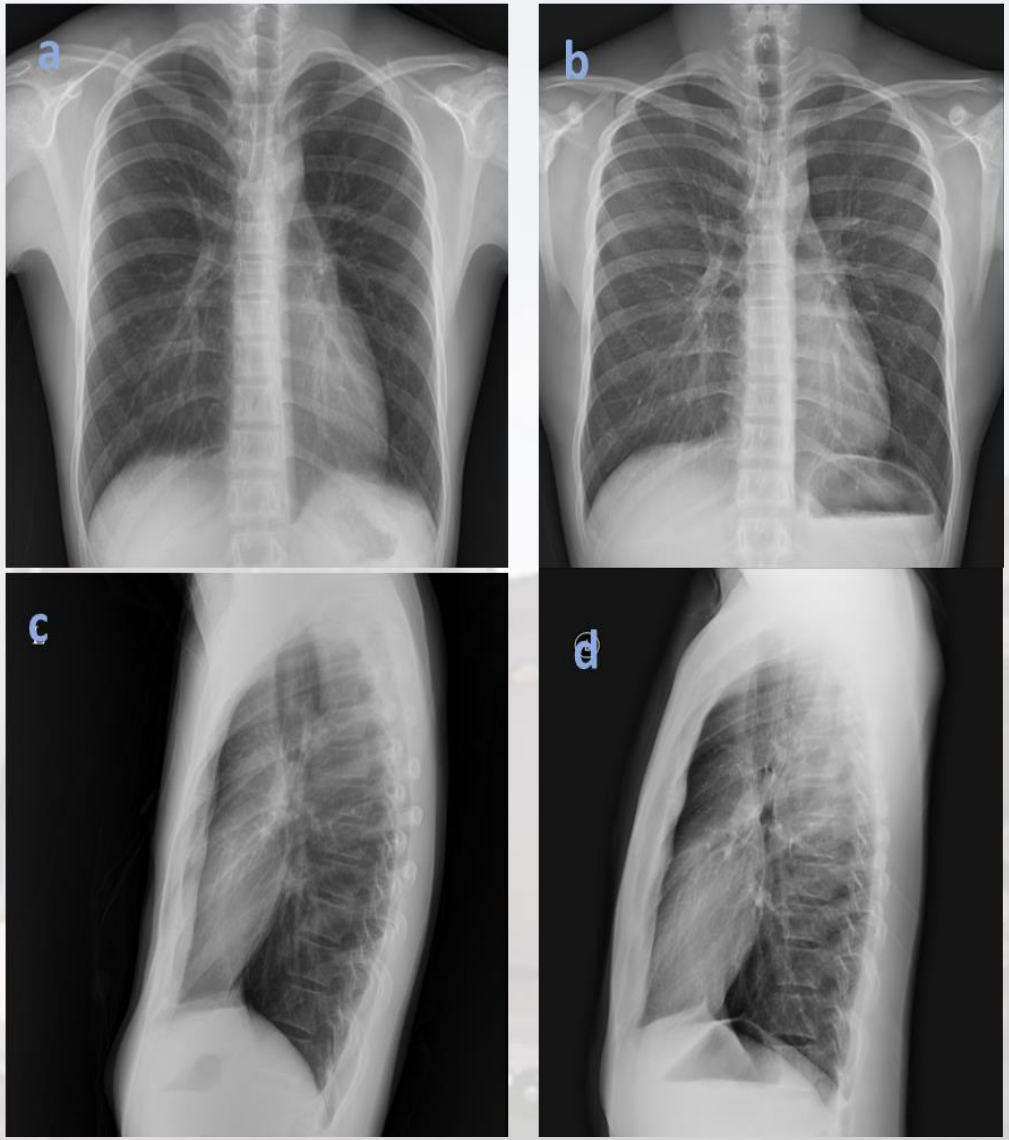


Measuring treatment outcomes

For Vacuum bell group

Initial

1-year after VB application



Follow-up; Vacuum bell vs Surgery

Table 2. Comparison of treatment effects and complications

Variable	Group 1 (n=33)	Group 2 (n=24)	Total (n=57)	p-value
Haller index				
Pre-treatment				
Chest CT	3.6±1.10 (2.1–6.7)	4.24±1.2 (2.9–8.5)	3.88±1.17 (2.1–8.5)	0.043
CXR	3.6±0.98 (2.2–8.3)	4.19±1.1 (3.0–8.3)	3.84±1.07 (2.2–8.3)	0.036
Post-treatment				
Immediate (CT)	3.06±0.67 (2.4–5.2)	3.07±0.46 (2.6–6.8)	3.06±0.59 (2.4–6.8)	0.954
After 1 yr (CXR)	3.01±0.62 (2.2–8.3)	2.88±0.78 (2.1–5.2)	2.96±0.69 (2.1–8.3)	0.473
Changes in Haller index				
Immediate (CT)	0.55±0.47 (0.02–1.53)	1.18±0.85 (0.92–1.11)	0.82±0.72 (0.02–1.53)	0.03
After 1 yr (CXR)	0.58±0.49 (0.25–2.08)	1.31±0.56 (0.95–1.82)	0.88±0.76 (0.25–2.08)	<0.01
Changes in AP diameter (mm)				
Chest CT	9.62±4.89 (1.2–21.7)	16.02±9.46 (1.3–30.2)	12.31±7.78 (1.2–30.2)	0.05
CXR	13.02±8.53 (2.4–28.2)	28.75±14.9 (5.4–36.2)	19.65±13.94 (2.4–36.2)	<0.01
Complications				NA
Chest tightness	1 (3.0)	NA	1 (3.0)	
Skin erosion	2 (6.06)	NA	2 (3.51)	
Skin erythema	1 (3.0)	NA	1 (1.75)	
Pleural effusion	NA	3 (12.5)	3 (5.26)	
Pneumothorax	NA	2 (8.33)	2 (3.51)	
Wound infection	NA	1 (4.17)	1 (1.75)	
Bar dislocation	NA	1 (4.17)	1 (1.75)	

How could we expect appropriate treatment results from Vacuum bell device in Pectus excavatum patients

Yi, E., Lee, K., Jung, Y., Chung, J. H., Kim, H. S., Lee, S., & Ahn, H. (2021). Finding suitable candidates for vacuum bell therapy in pectus excavatum patients. Scientific Reports, 11(1), 22787.

- Between January 2016 and December 2019
- Retrospective review of Clinical data

- Enrolled patients categorized into 2 groups
  - ✓Maintained Vacuum bell therapy more than 1-year
  - ✓According to the median value of changes in Haller index (0.5)
    - ➢Group 1 (33); Changes in Haller index (HI) <0.5
    - ➢Group 2 (30); Changes in HI ≥0.5

Methods

- Expected changes of thoracic indices
  - ✓ ΔHI, ΔCI, and ΔAI from pre-treatment chest CT
  - ✓ Sternal depths were measured every 3-month
- Treatment efficacy after 1-year treatment
  - ✓ Changes in HI using chest X-ray
  - ✓ Complication rates

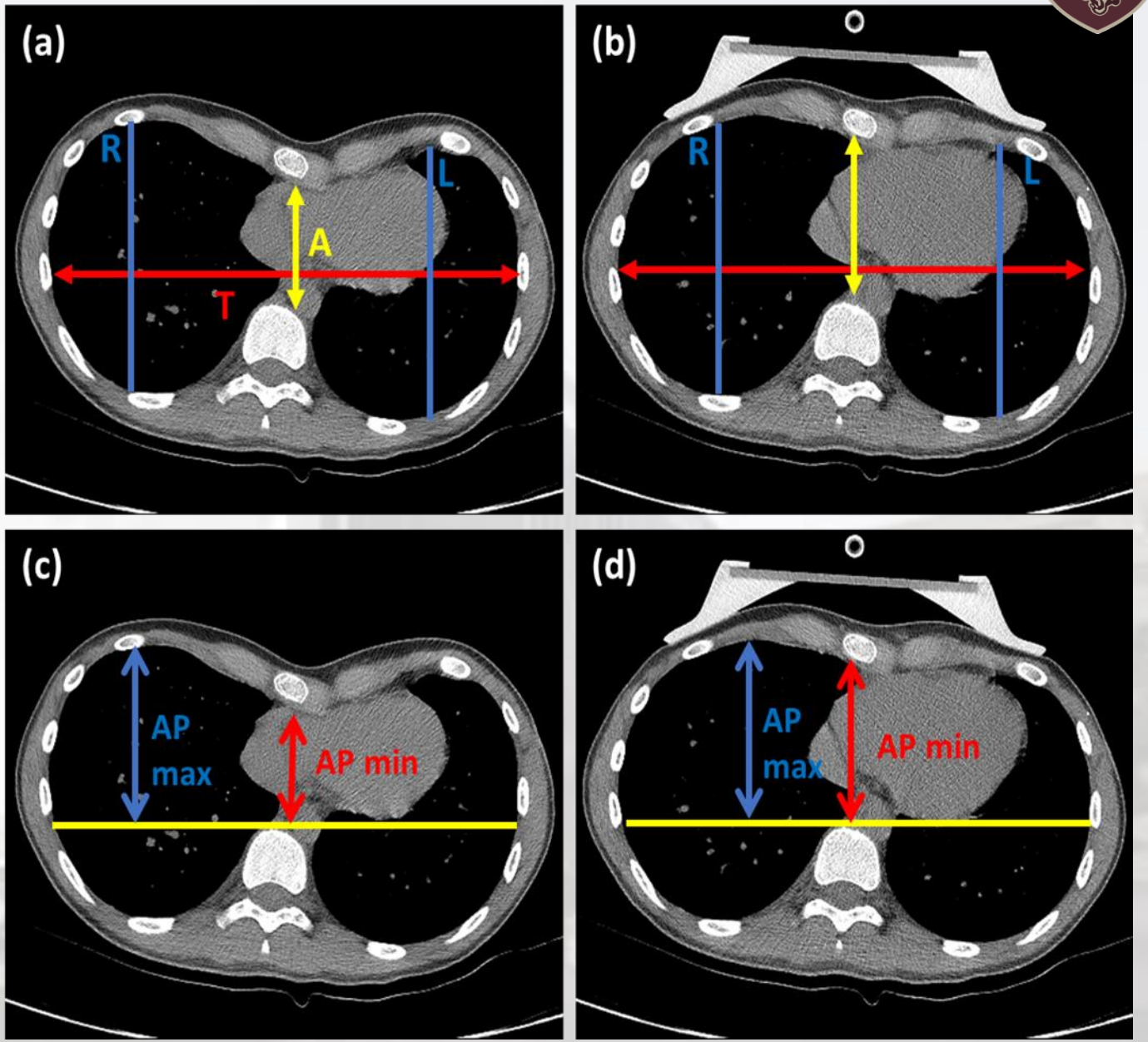
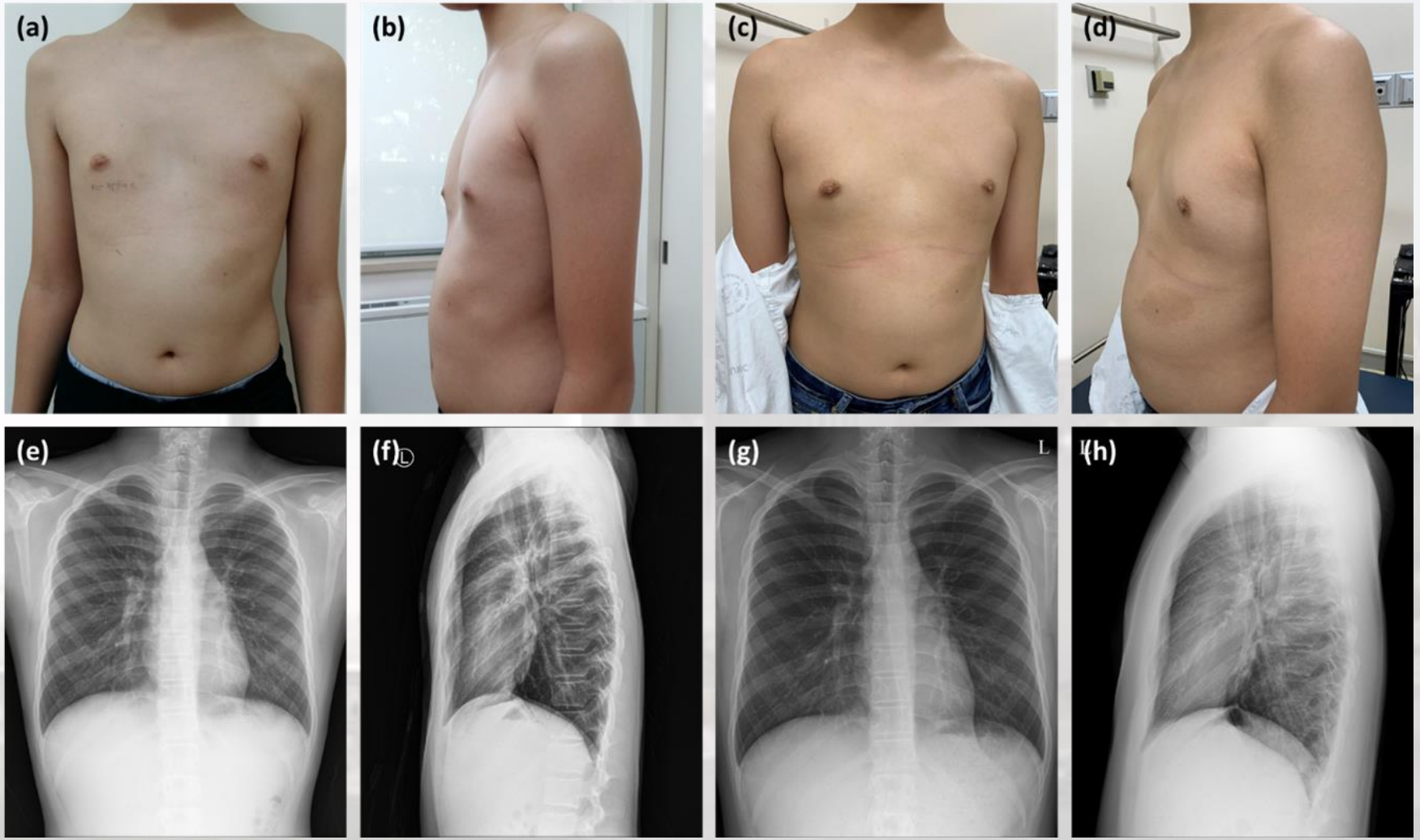


Figure 2. Measurement of AI and CI chest CT (a) Measuring AI before applying vacuum bell (VB) device (b) Measurement of AI during application of a VB device: Assessments were performed using the chest CT slice as that used before. AI=R/L. (C) Measuring CI before and (d) after applying a VB device. CI = ([AP max]-[Ap min])/[AP max]).

Measurement of changes in HI after 1-year treatment

Figure 3. Evaluation of treatment outcomes after 1 year of vacuum bell (VB) application. Pictures and chest radiographs were taken from a 17-year-old male patient just before starting treatment (a, b, e, f) and at 1 year after VB therapy (c, d, g, and h). (a) Anterior view before VB application; (b) lateral view before VB application; (c) anterior view at 1 year after treatment; (d) lateral view at 1 year after treatment; (e) anteroposterior view on chest radiographs taken before starting therapy; (f) lateral view before starting therapy; (g) anterolateral view after 1 year of treatment; and (h) Lateral view after 1 year of treatment.



Data

- Mean Treatment periods; 21.6 months (±7.30, ranging 12.1 to 41.8 months)
- Mean age at the beginning of therapy; 15.4 (±36.23, ranging 8 to 45)
  - ✓ Group1; 16.0 (±7.54, ranging 8 to 45)
  - ✓ Group2; 14.2 (±4.18, ranging 9 to 34)
- Men: Women =61:2

Variables	Group 1 (N=33) mean±sd. (range)	Group 2 (N=30) mean±sd. (range)	Total mean±sd. (range)	p-value
Age	16.0±7.54 (8-45)	14.2±4.18 (9-34)	15.4±6.23 (8-45)	0.254
Sex				0.493
Female	2 (6.1%)	0 (0.0%)	2 (3.2%)	
Male	31 (93.9%)	30 (100.0%)	61 (96.8%)	
BMI (kg/m^2)	19.0±2.39 (16-25)	16.4±3.84 (9-21)	(17.8±3.45) (9-25)	0.001
Family history				0.094
No	32 (56.1%)	25 (83.3%)	57 (90.5%)	
Yes	1 (3.0%)	5 (16.7%)	6 (9.5%)	
Smoking history				0.334
None	29 (87.9%)	29 (96.7%)	58 (92.1%)	
Ex.	2 (6.1%)	0 (0.0%)	2 (3.2%)	
Current	2 (6.1%)	1 (3.3%)	3 (4.8%)	
Comorbidity				0.535
Mitral regurgitation	0 (0.0%)	1 (3.0%)	1 (1.6%)	
Scoliosis	1 (3.0%)	1 (3.0%)	2 (3.2%)	
Arrythmia	1 (3.0%)	0 (0.0%)	1 (1.6%)	
Atopy	0 (0.0%)	1 (3.0%)	1 (1.6%)	
Onset periods				0.922
Infant (0~1-year)	0 (0.0%)	1 (3.3%)	1 (1.6%)	
Toddler (1~3-year)	1 (3.0%)	1 (3.3%)	2 (3.2%)	
Child (3 ~ 10-year)	9 (27.3%)	8 (26.7%)	17 (27.0%)	
Preadolescent (10 ~ 13-year)	13 (39.4%)	11 (36.7%)	24 (38.1%)	
Adolescent (13 ~ 19-year)	8 (24.2%)	8 (26.7%)	16 (25.4%)	
Adult (>19-year)	2 (6.1%)	1 (3.3%)	3 (4.8%)	
EKG findings				0.473
NSR	31 (93.9%)	26 (86.7%)	57 (90.5%)	
Sinus bradycardia	2 (6.1%)	3 (10.0%)	5 (7.9%)	
Incomplete RBBB	0 (0.0%)	1 (3.3%)	1 (1.6%)	
Nuss operation history				0.321
Yes	0 (0.0%)	1 (3.3%)	1 (1.6%)	
No	33 (100.0%)	29 (96.6%)	62 (98.4%)	
Symptoms				0.359
Chest discomfort	0 (0.0%)	1 (3.3%)	1 (1.6%)	
Palpitation	0 (0.0%)	1 (3.3%)	1 (1.6%)	
Dyspnea	1 (3.0%)	0 (0.0%)	1 (1.6%)	
Cough	0 (0.0%)	1 (3.3%)	1 (1.6%)	
Low body weight	0 (0.0%)	1 (3.3%)	1 (1.6%)	
None	32 (97.0%)	26 (86.7%)	58 (92.1%)	

Table 1. Basic Patient Characteristics

Table 2. Thoracic indices before and after vacuum bell therapy

Variables	Group 1 (N=33) mean±sd. (95% CI)	Group 2 (N=30) mean±sd. (95% CI)	Total (N=63) mean±sd. (95% CI)	p-value
Haller Index				
Pre-treatment				
CXR	3.1±0.46 (2.2–8.3)	4.2±1.14 (3.0–8.3)	3.6±1.00 (2.2–8.3)	<0.001
Chest CT				
Without VB application	3.2±0.79 (2.2–6.7)	4.2±1.16 (2.9–8.5)	3.7±1.10 (2.2–8.9)	<0.001
With VB application (Expected HI)	2.8±0.54 (2.1–5.2)	3.3±0.60 (2.2–4.5)	3.0±0.61 (2.1–5.2)	0.001
Changes in AP diameter (mm)	9.3±5.48 (1.2-21.7)	15.0±6.80 (2.4–28.2)	12.0±6.72 (1.2–28.2)	0.001
Changes in AP diameter (%)	12.7±8.23 (9.8-15.6)	27.6±19.82 (20.1-35.0)	19.8±16.57 (15.6-23.9)	<0.001
Post-treatment (CXR)				
1-year FU	2.9±0.46 (2.0–3.9)	3.2±0.93 (2.4–6.8)	3.1±0.73 (2.0–6.8)	0.292
Asymmetry Index				
Without VB application	1.00±0.780 (0.84–1.21)	0.97±0.638 (0.85–1.12)	0.98±0.719 (0.84–1.21)	0.366
With VB application (Expected)	1.00±0.061 (0.89–1.11)	0.97±0.079 (0.82–1.15)	0.98±0.071 (0.82–1.15)	0.228
Correction Index				
Without VB application	0.14±0.826 (0.00–0.38)	0.23±0.125 (0.03–0.49)	0.18±0.114 (0.00–0.49)	0.003
With VB application (Expected)	0.14±0.826 (0.00–0.23)	0.15±0.125 (0.00–0.59)	0.10±0.106 (0.00–0.59)	0.001
Changes in HI				
Pre-post VB application	0.39±0.308 (0.02–1.53)	0.97±0.782 (0.28–4.37)	0.67±0.648 (0.02–4.37)	<0.001
After treatment	0.18±0.197 (0.25–0.46)	0.93±0.400 (0.50–2.08)	0.54±0.487 (0.25–2.08)	<0.001
Depth of PE (cm)				
Initial	2.3±1.14 (0.0–6.2)	2.7±0.92 (0.0–4.3)	2.4±1.06 (0.0–6.2)	0.021
5-minute After VB application	1.9±0.80 (0.0–3.7)	2.2±0.89 (0.0–3.7)	2.0±0.85 (0.0–3.7)	0.088
3-month FU	2.0±0.76 (0.0–3.5)	2.3±0.84 (0.0–4.0)	2.2±0.81 (0.0–4.0)	0.030
6-month FU	1.9±0.82 (0.0–3.4)	2.2±0.80 (0.0–3.5)	2.0±0.83 (0.0–3.5)	0.053
1-year FU	1.6±0.92 (0.0–3.2)	2.0±0.81 (0.0–3.2)	1.8±0.88 (0.0–3.2)	0.061
Changes after treatment	0.67±1.002 (-1.50–3.10)	0.66±0.838 (-2.40–2.50)	0.67±0.921 (-2.40–3.10)	0.957
1-year changes after treatment (%)	32.6±33.44 (19.9-45.3)	27.7±23.05 (18.8-36.7)	30.2±28.66 (22.6-37.8)	0.665

Table 3. Application of Vacuum bell therapy and complications

Variables	Group 1 (N=33) mean±sd. (95% CI)	Group 2 (N=30) mean±sd. (95% CI)	Total (N=63) mean±sd. (95% CI)	p-value
Vacuum bell application duration (Hour)				**0.669**
0.5	3 (9.1%)	4 (13.3%)	7 (11.1%)	
1	25 (75.8%)	20 (66.7%)	45 (71.4%)	
2	5 (15.2%)	5 (16.7%)	10 (15.9%)	
3	0 (0.0%)	1 (3.3%)	1 (1.6%)	
Vacuum bell application frequency (per day)				**0.671**
1	11 (33.3%)	12 (40.0%)	23 (36.5%)	
2	17 (51.5%)	13 (43.3%)	30 (47.6%)	
3	4 (12.1%)	5 (16.7%)	9 (14.3%)	
4	1 (3.0%)	0 (0.0%)	1 (1.6%)	
Vacuum bell size				**0.487**
1	5 (15.2%)	7 (23.3%)	12 (19.0%)	
2	22 (52.4%)	20 (66.7%)	42 (66.7%)	
3	4 (57.1%)	3 (10.0%)	7 (11.1%)	
4	6 (6.1%)	0 (0.0%)	2 (3.2%)	
Complications				**0.457**
Chest tightness	1 (3.0%)	1 (3.3%)	2 (3.2%)	
Skin erosion	1 (3.0%)	2 (6.7%)	3 (4.8%)	
Skin erythema	0 (0.0%)	1 (3.3%)	1 (1.6%)	
Follow-up BMI	19.5±2.25 (18.6-20.5)	18.0±5.46 (15.9-20.0)	18.7±4.29 (17.6-19.9)	**0.390**
Poor compliance	6 (18.2%)	5 (16.7%)	11 (17.5%)	**1.000**

Trends of Changes in Sternal Depth

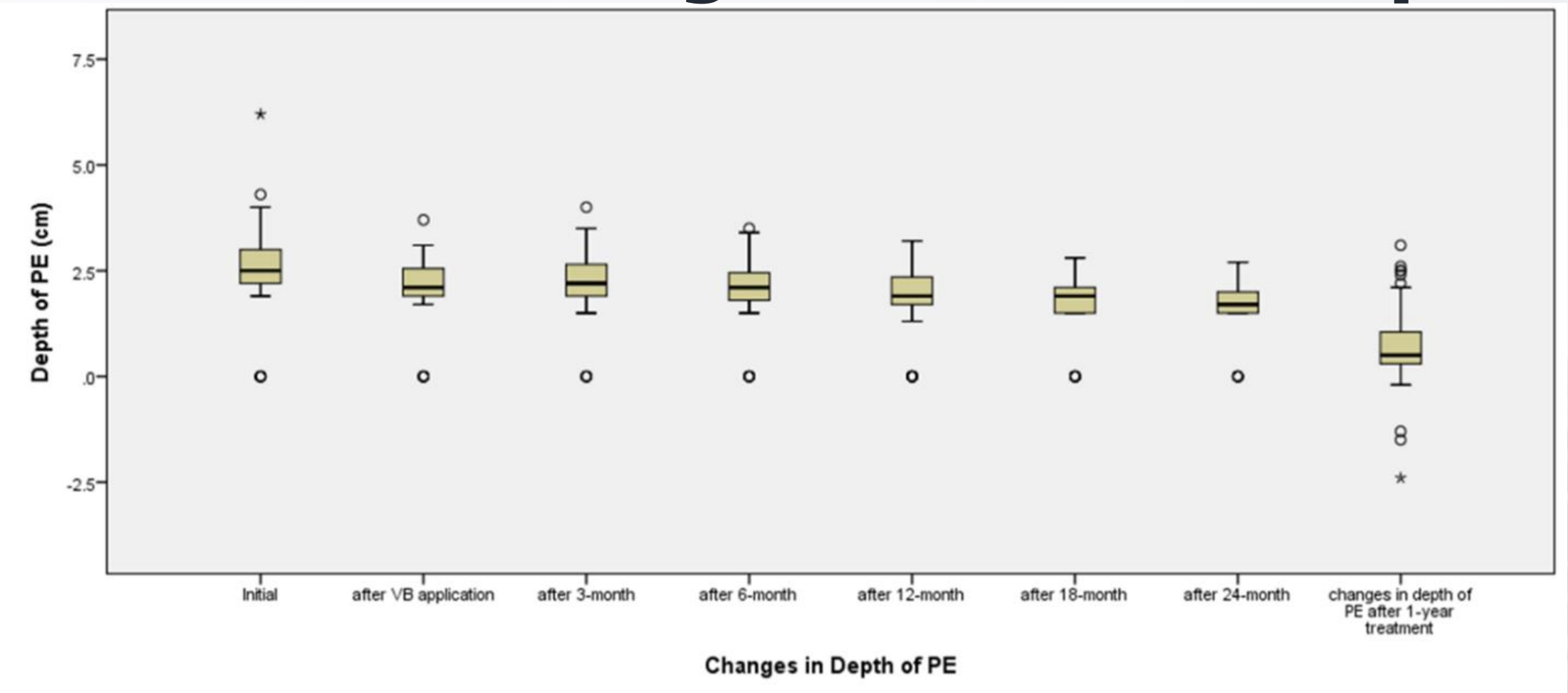


Figure 5. Distribution of depth of pectus excavatum (PE) according to the treatment periods. The initial mean depth was 2.4±1.06cm (range, 0.0–6.2), and the depth at 5 minutes after vacuum bell application was 2.0±1.06cm (range, 0.0–3.7). The actual changes in depth of PE after 1 year of treatment was 0.67±1.06cm (range, -2.4–3.10), which was not significantly different between Group 1 and Group 2. The changes in the depth of PE appeared to not be predictive factors of treatment outcomes; the graph could suggest the possible trends in sternal depth after applying a vacuum bell device.

Results

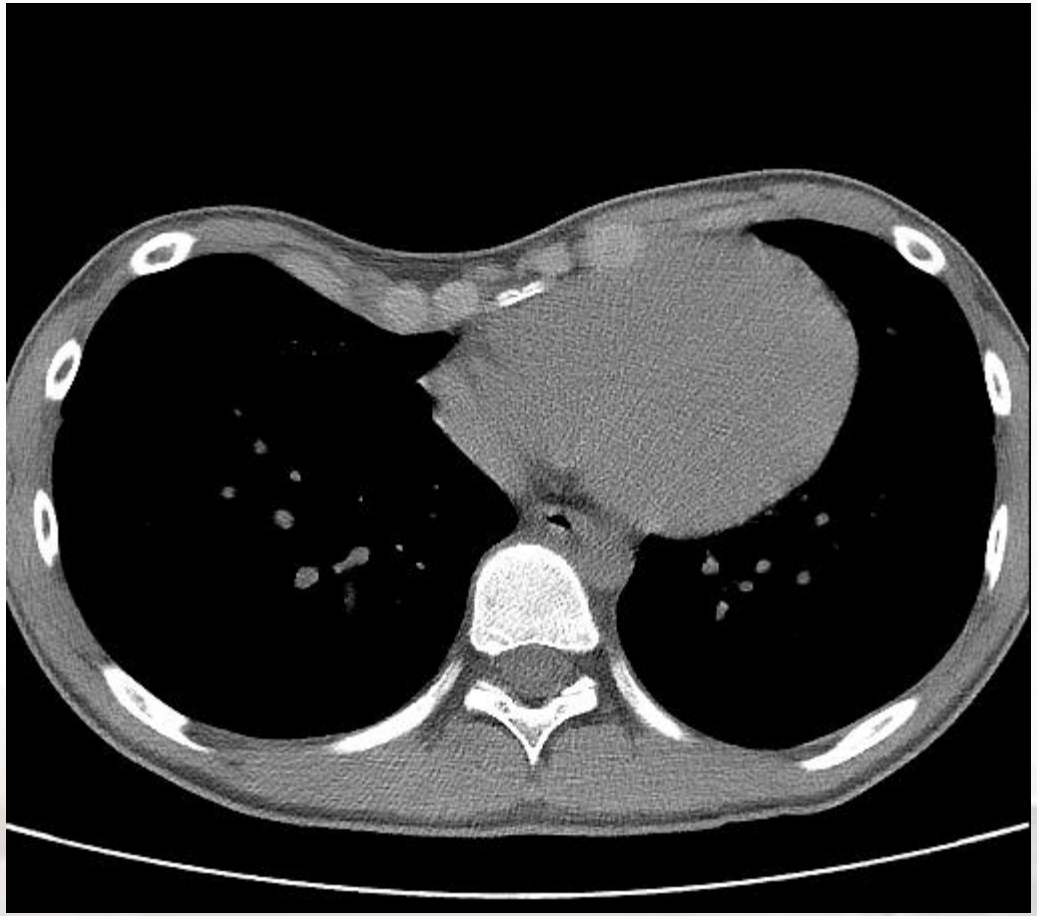
- Short-term treatment result of Vacuum bell therapy seemed safe and feasible.
  - ✓With minor complications
  - ✓4 cases of skin erosion and 2 cases of chest discomfort
- Expected improvements in HI as well as CI based on pre-treatment chest CT after applying a vacuum bell device could be used in predicting treatment efficacy.
- Patients who showed pliability with vacuum bell devices before starting treatment could be identified as suitable candidates.
- Poor compliance (11 cases, 17.5%) could be problem for appropriate evaluation of treatment.

Case 1; M/10Y,
VB application for 9-month

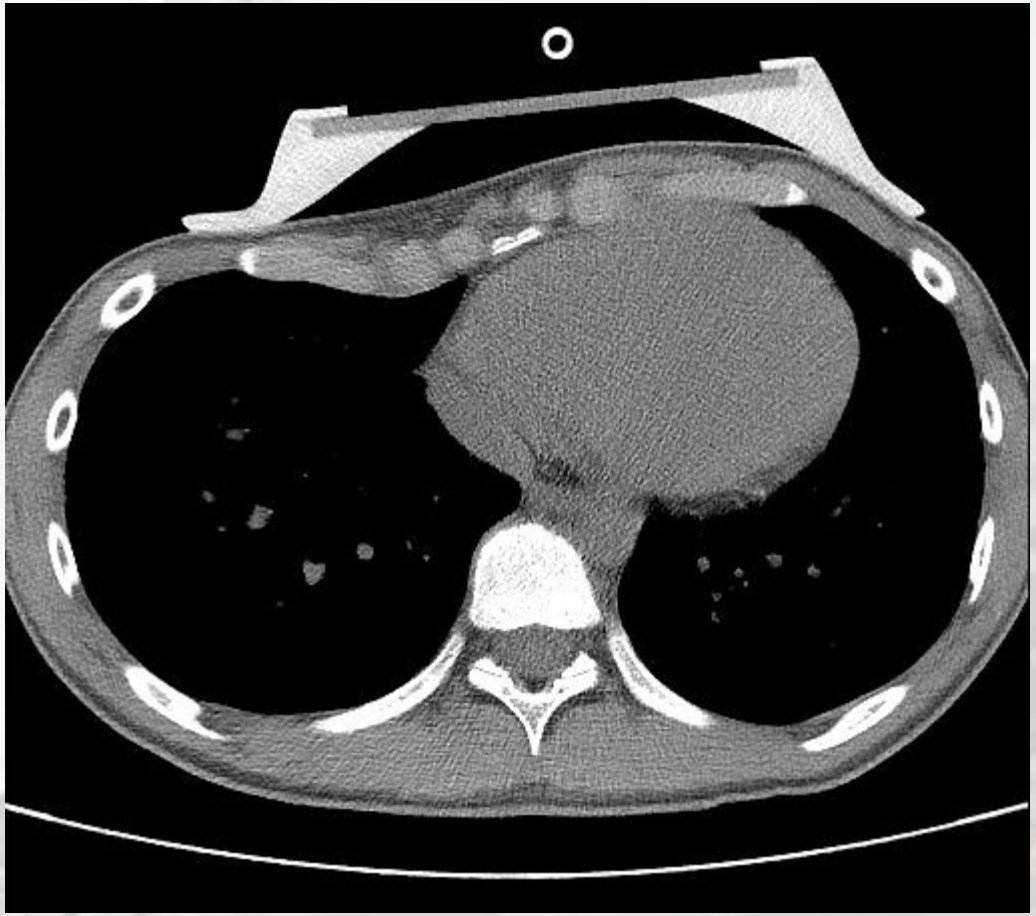
Case 2; M/18
VB application for 4Y 7months

Pre-treatment measurement of HI

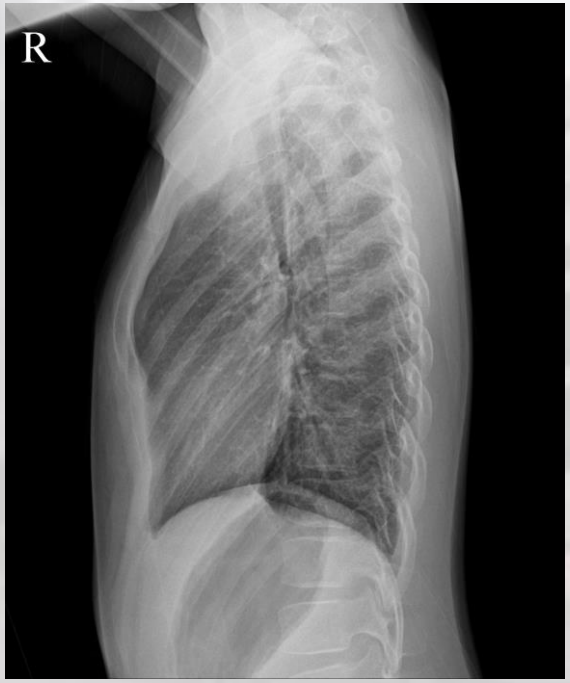
HI before applying VB; 3.8



HI after applying VB; 3.4



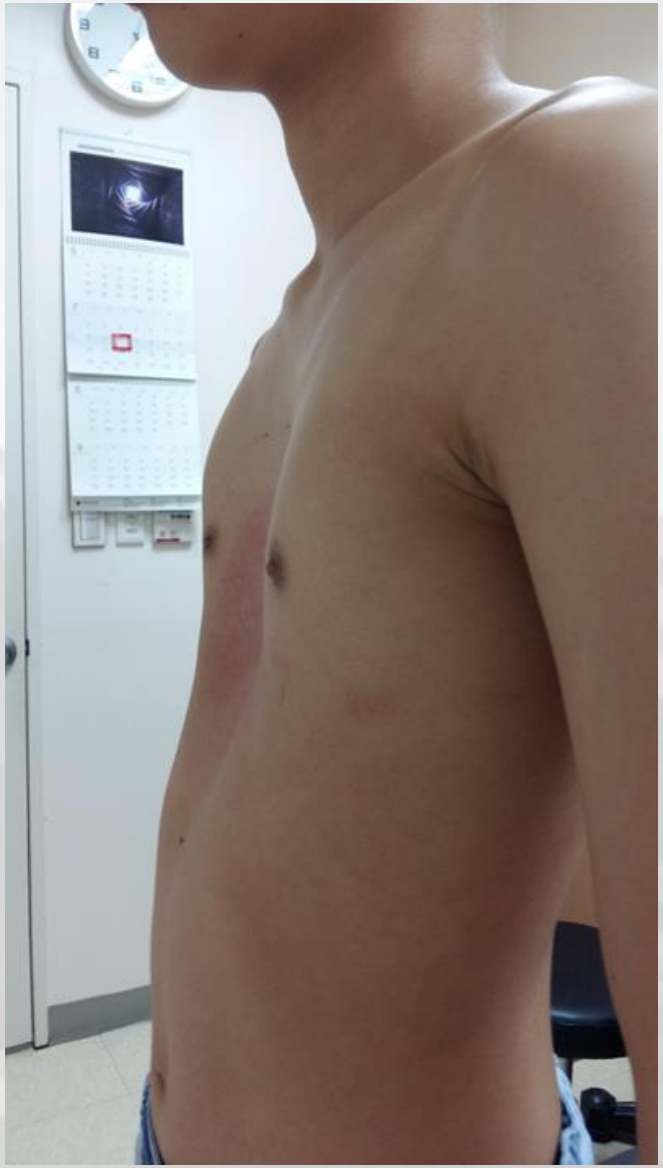
Case 3; F/9
VB application for 9-month



Case 4; M/14

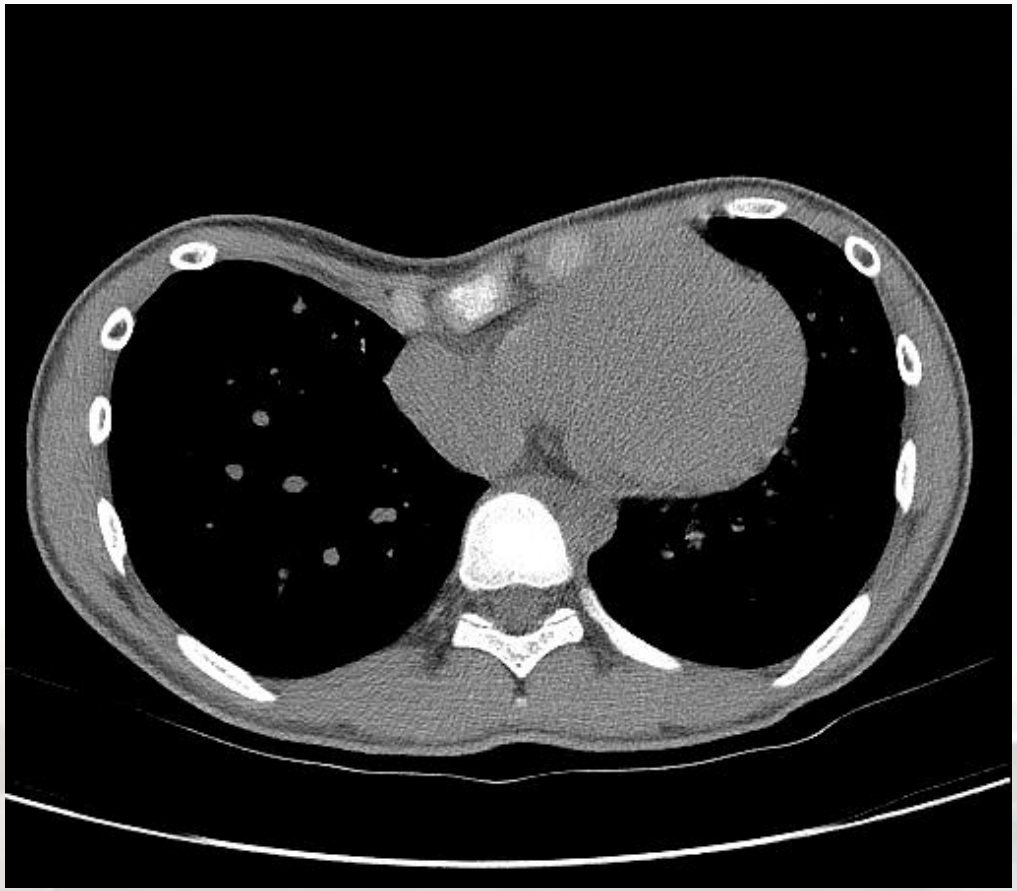
- Symmetric
- Initial sternal depth; 4cm
- Post VB; 2.8cm

- 18-month FU; 2.5cm

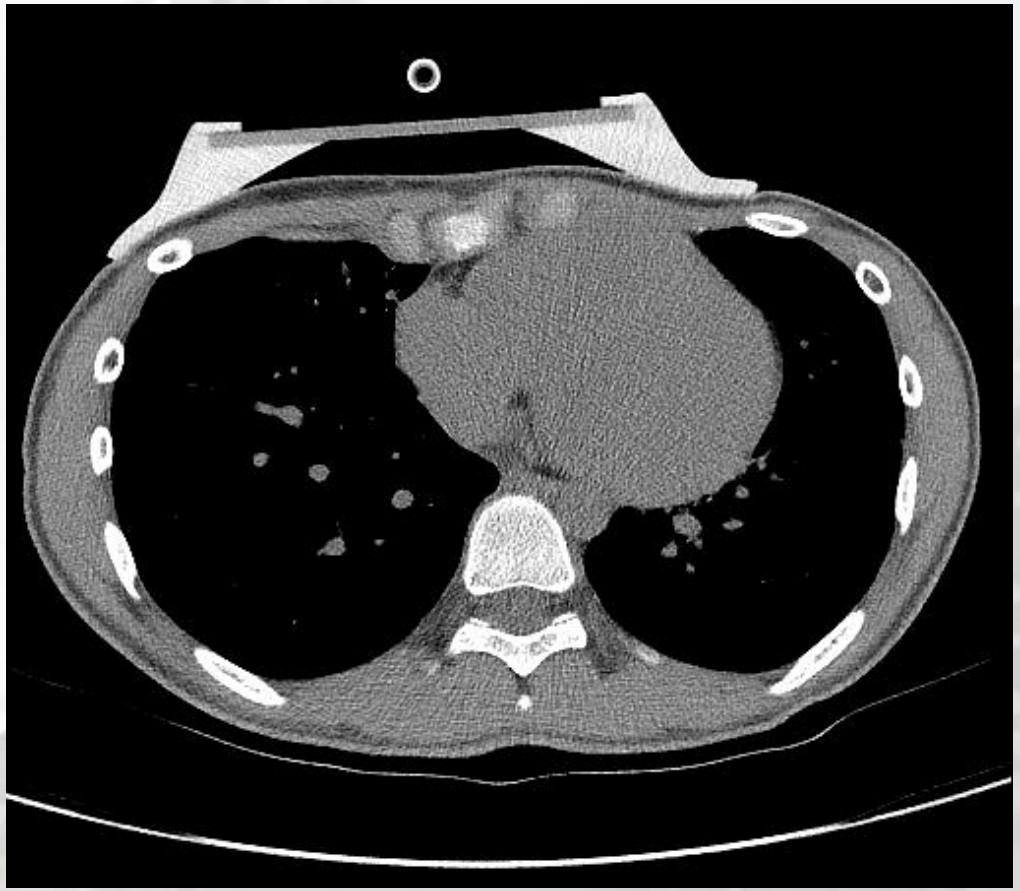


Pre-treatment measurement of HI

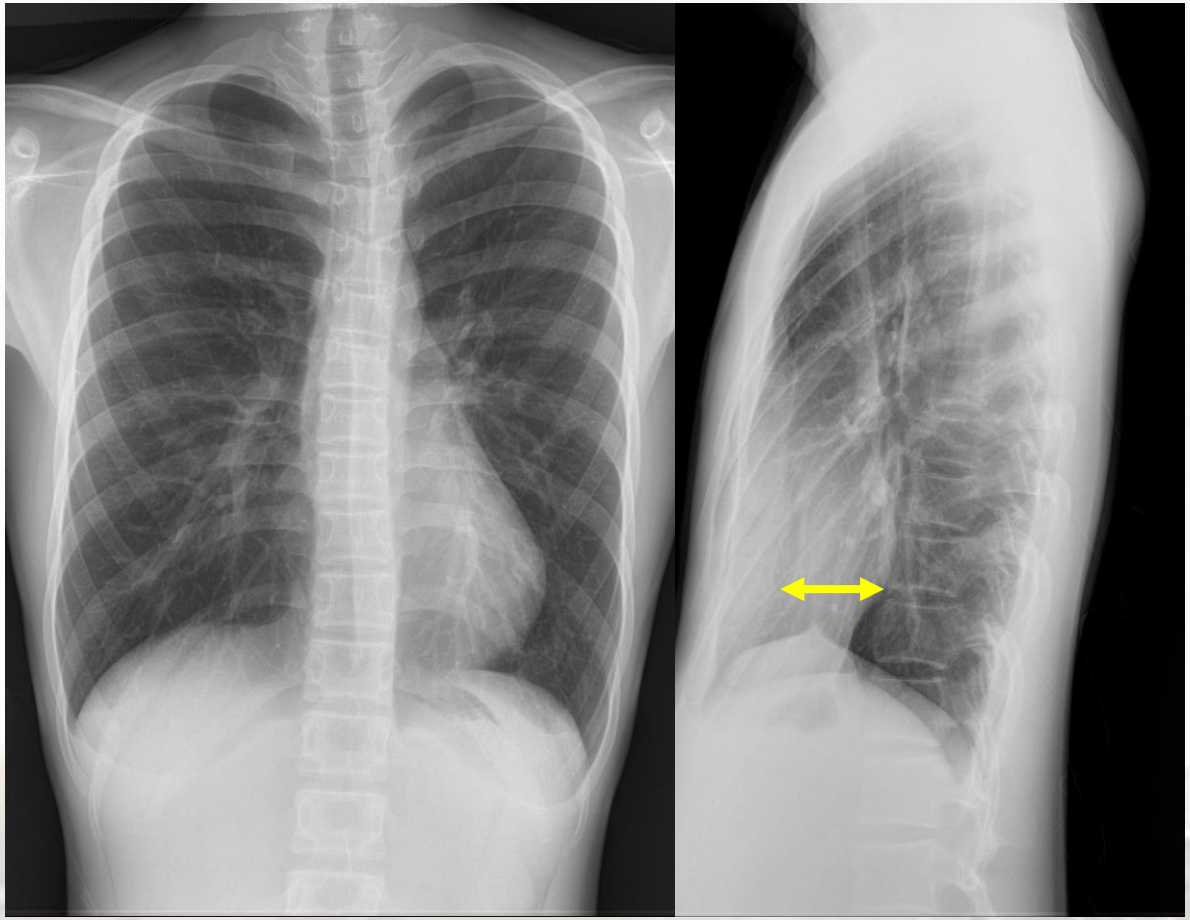
HI before applying VB; 4.3

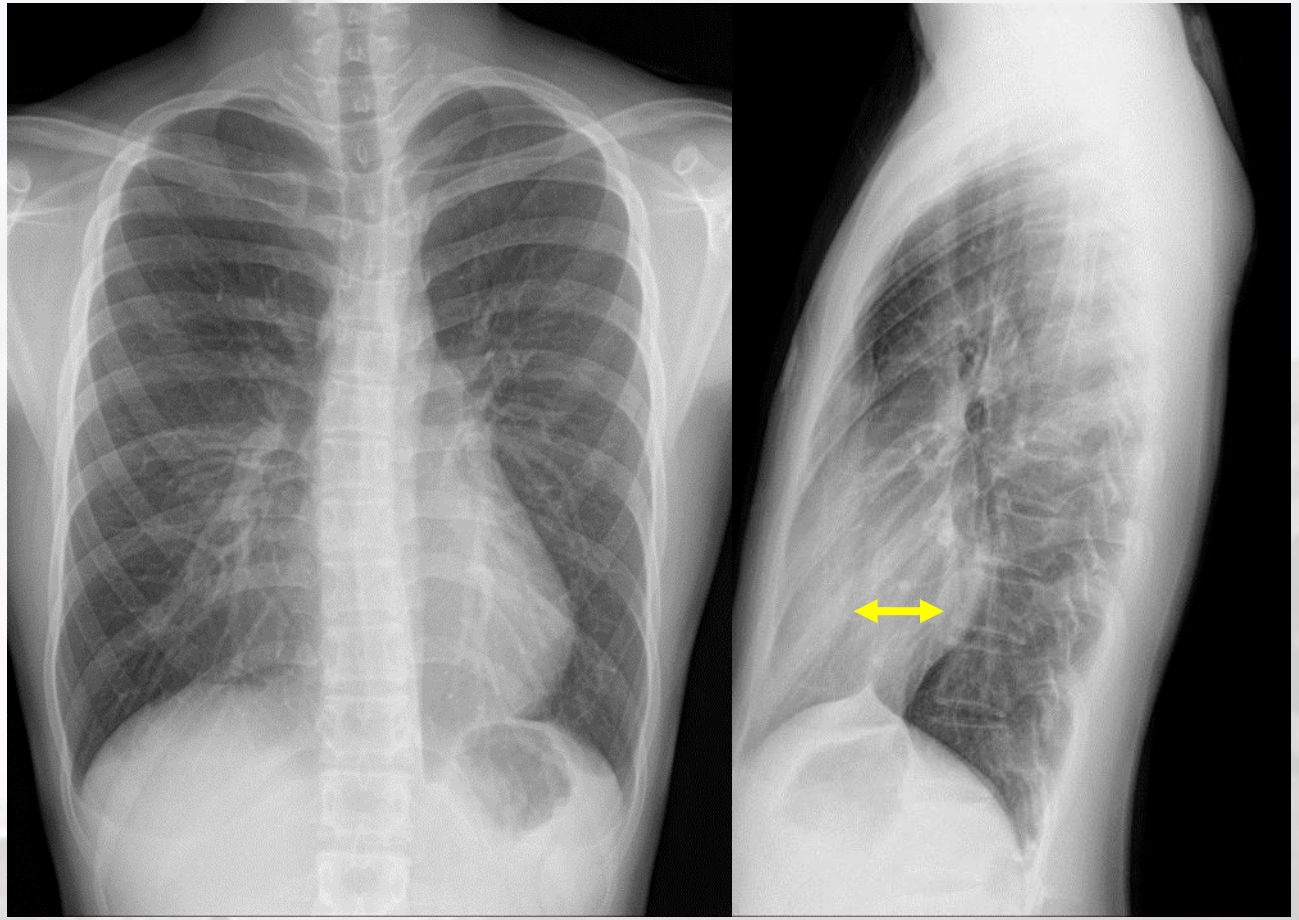


HI after applying VB; 3.2



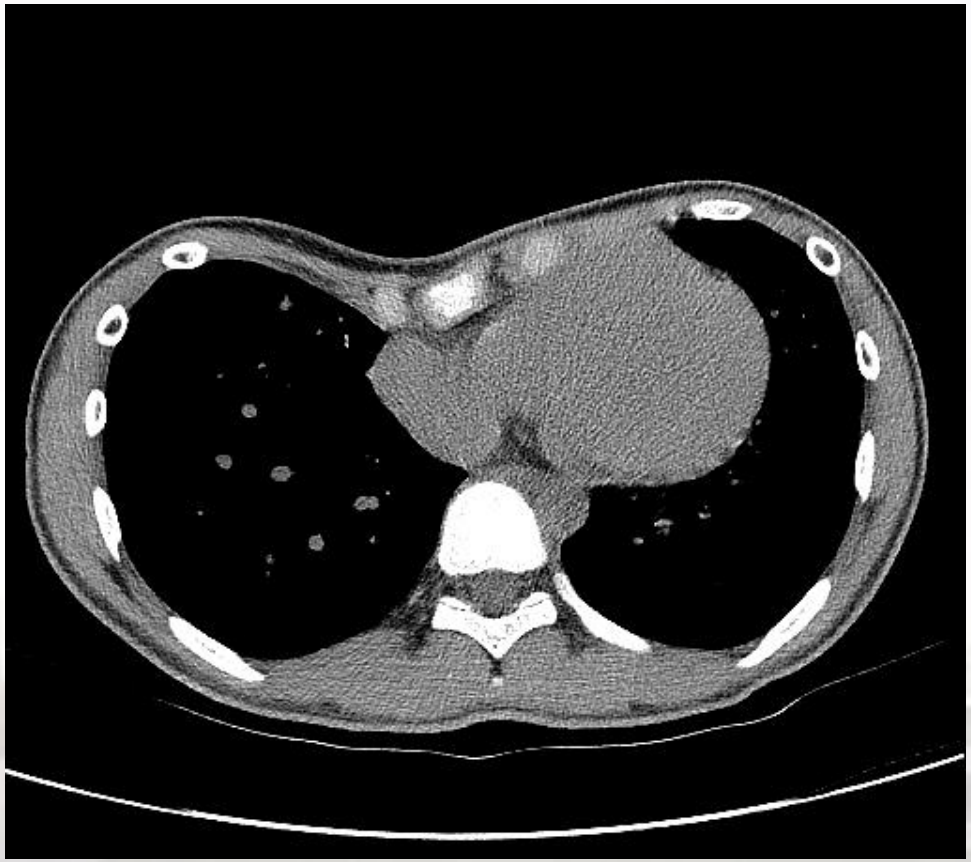
2017 vs 2019; Chest X-ray



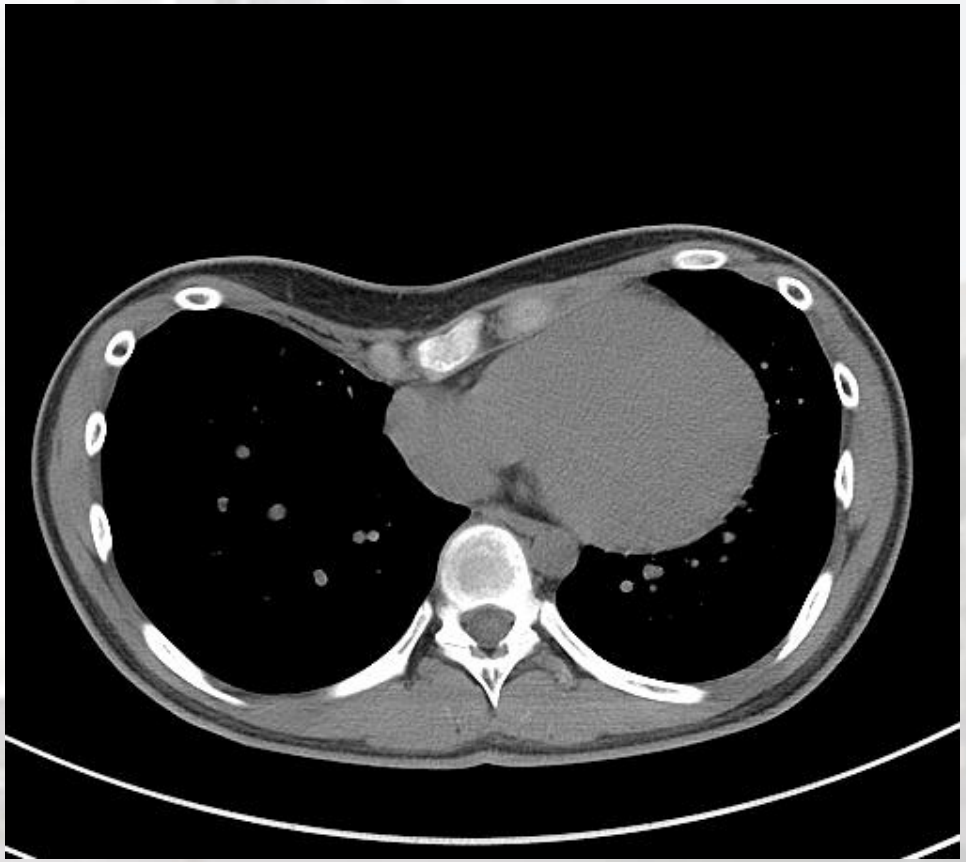


2017 vs 2019; Chest CT

HI before applying VB; 4.3

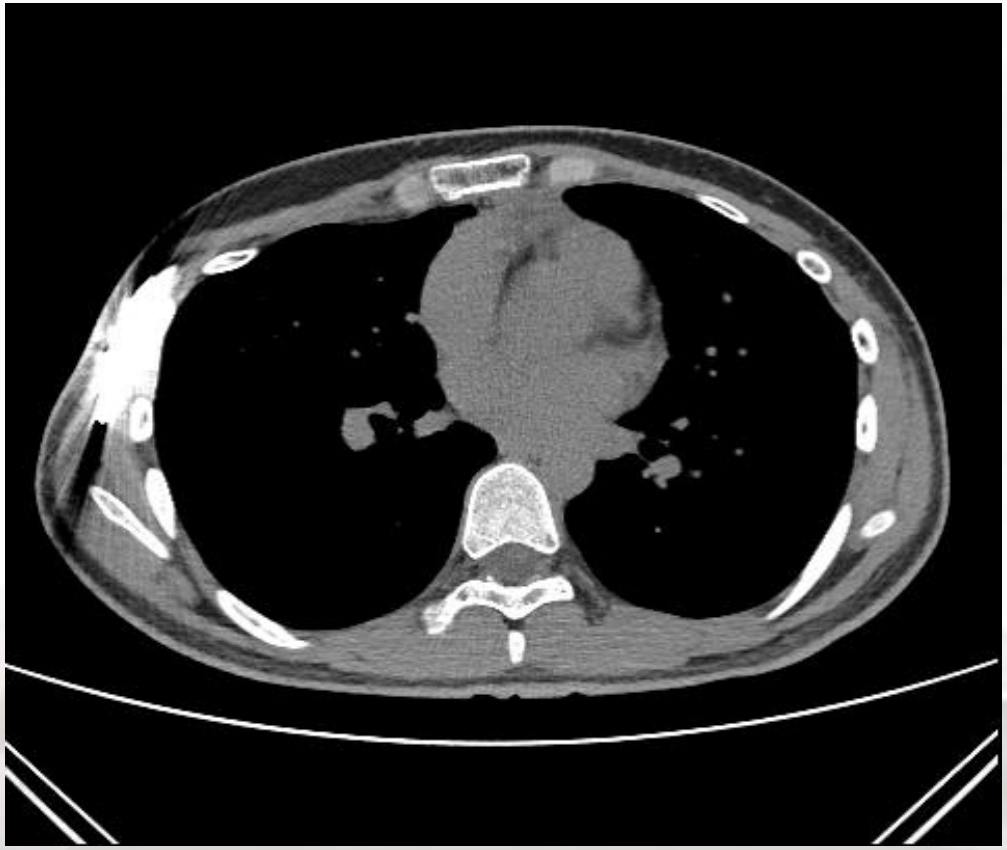


HI after applying VB; 5.0

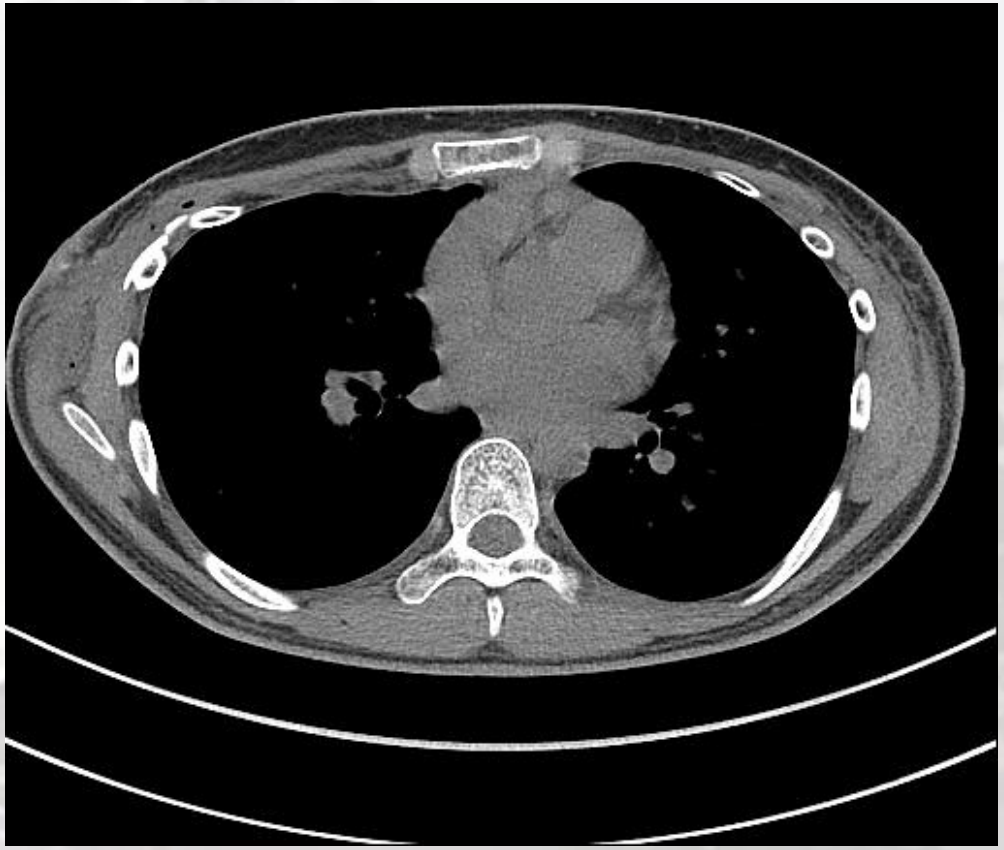


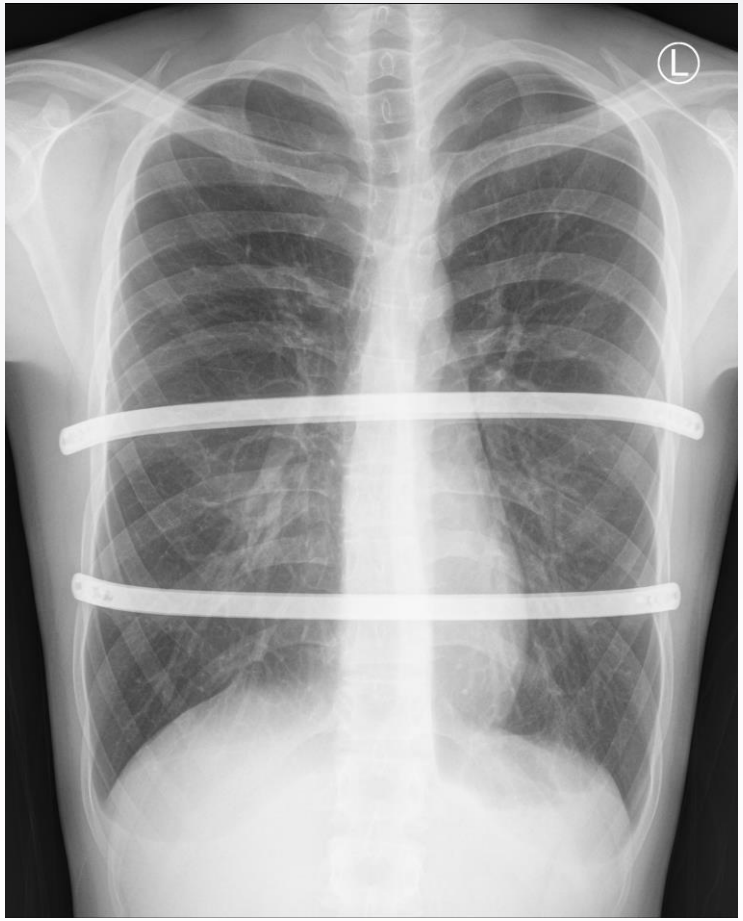
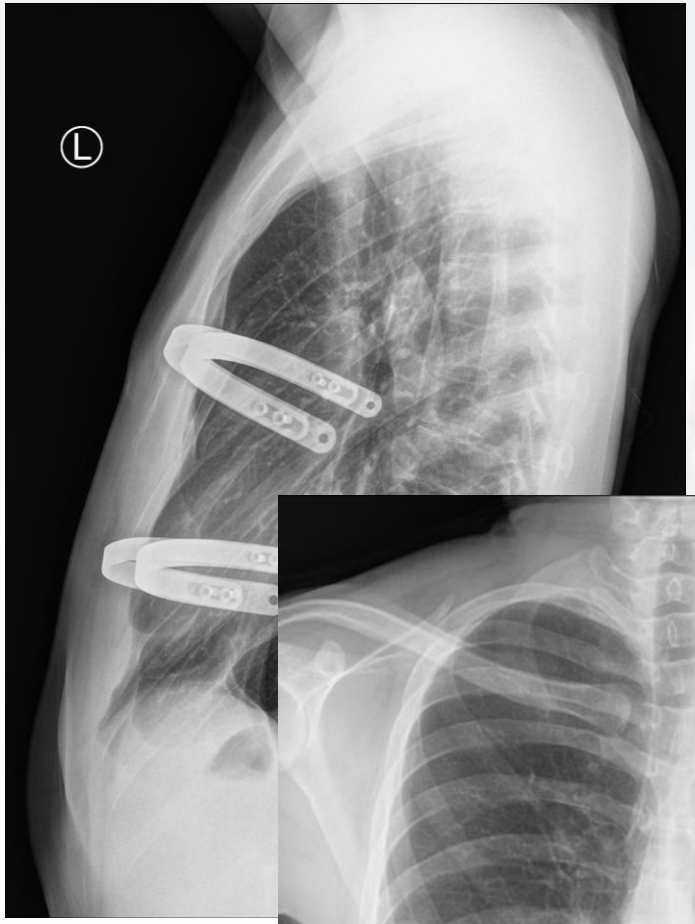
Post bar insertion/post bar removal

HI during bar insertion; 2.6

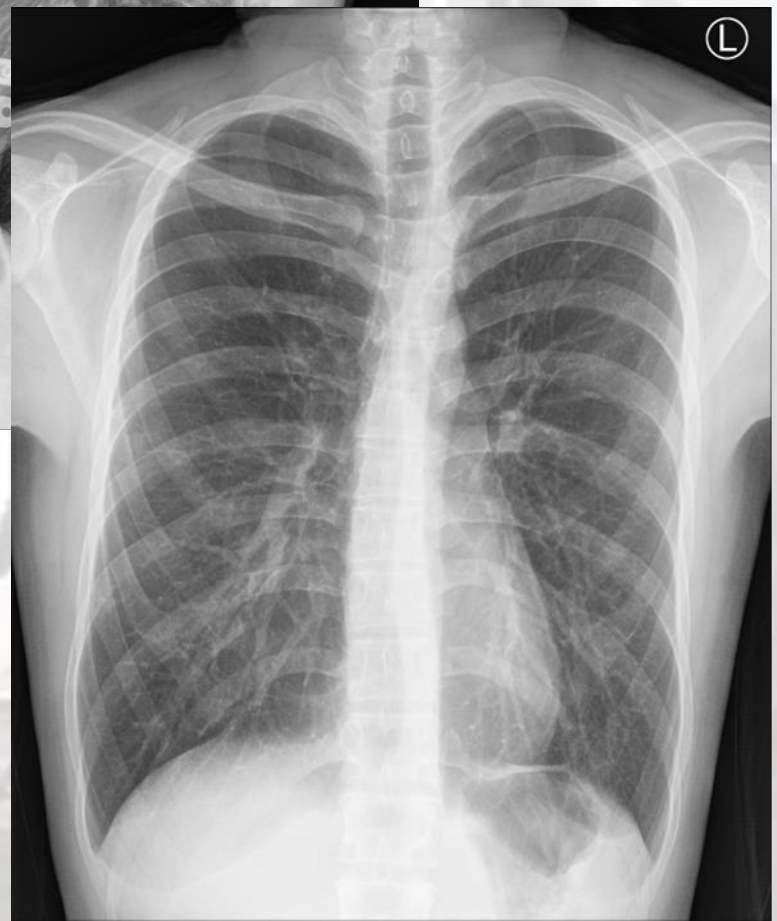


HI after bar removal; 2.8



HI; 2.6




1-year FU HI; 2.8

Case 5 M/13

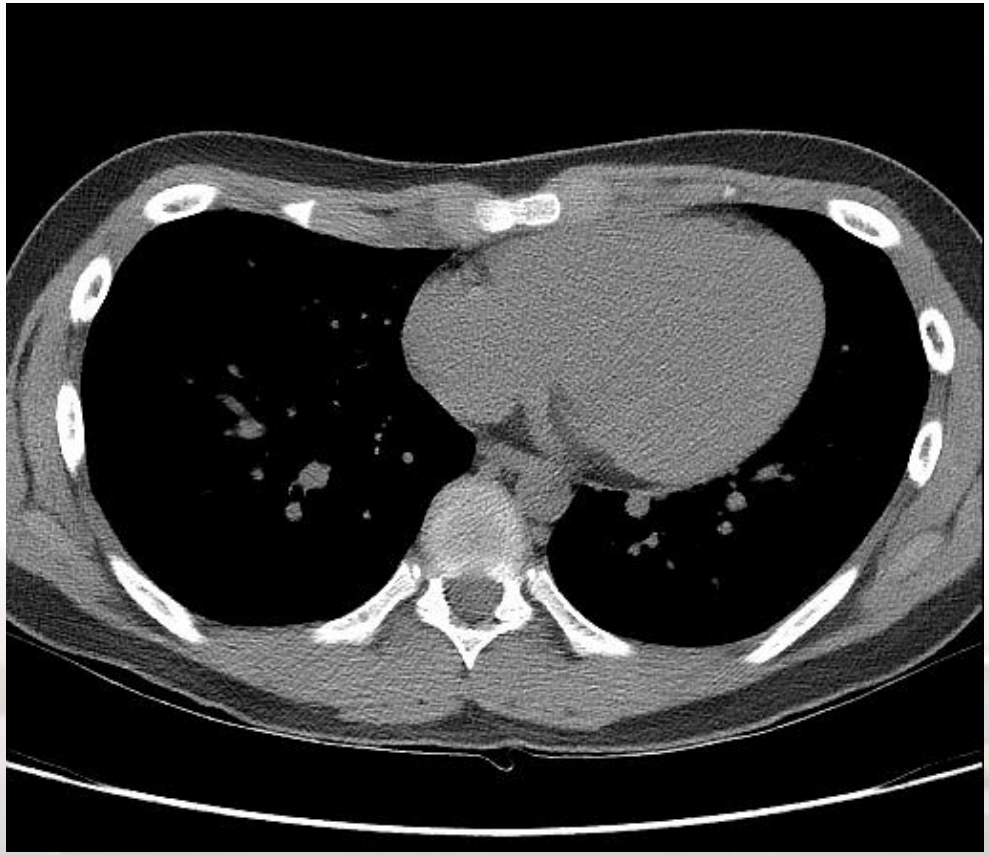
- Onset; 10세
- Symmetric depression
- Initial sternal depth; 2.2cm
- Post VB; 1.8cm

- Initial treatment plan; Op rec

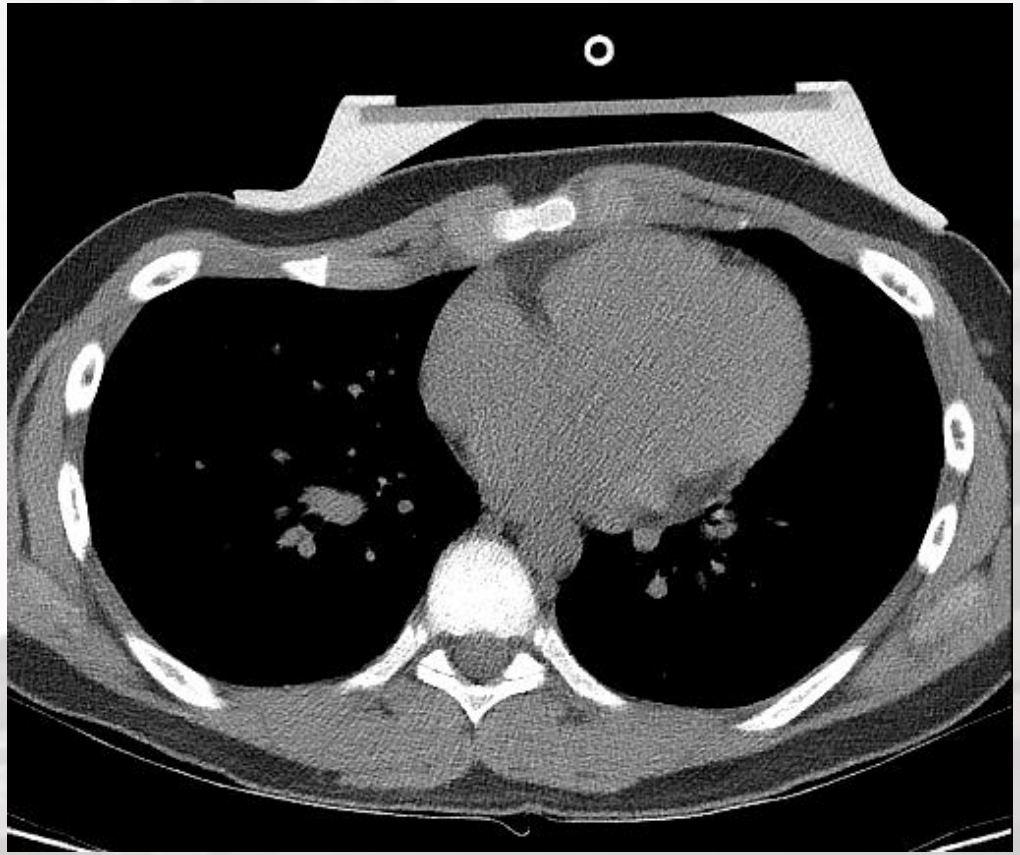
- 18-month FU; 2.0cm

Pre-treatment measurement of HI

HI before applying VB; 3.5



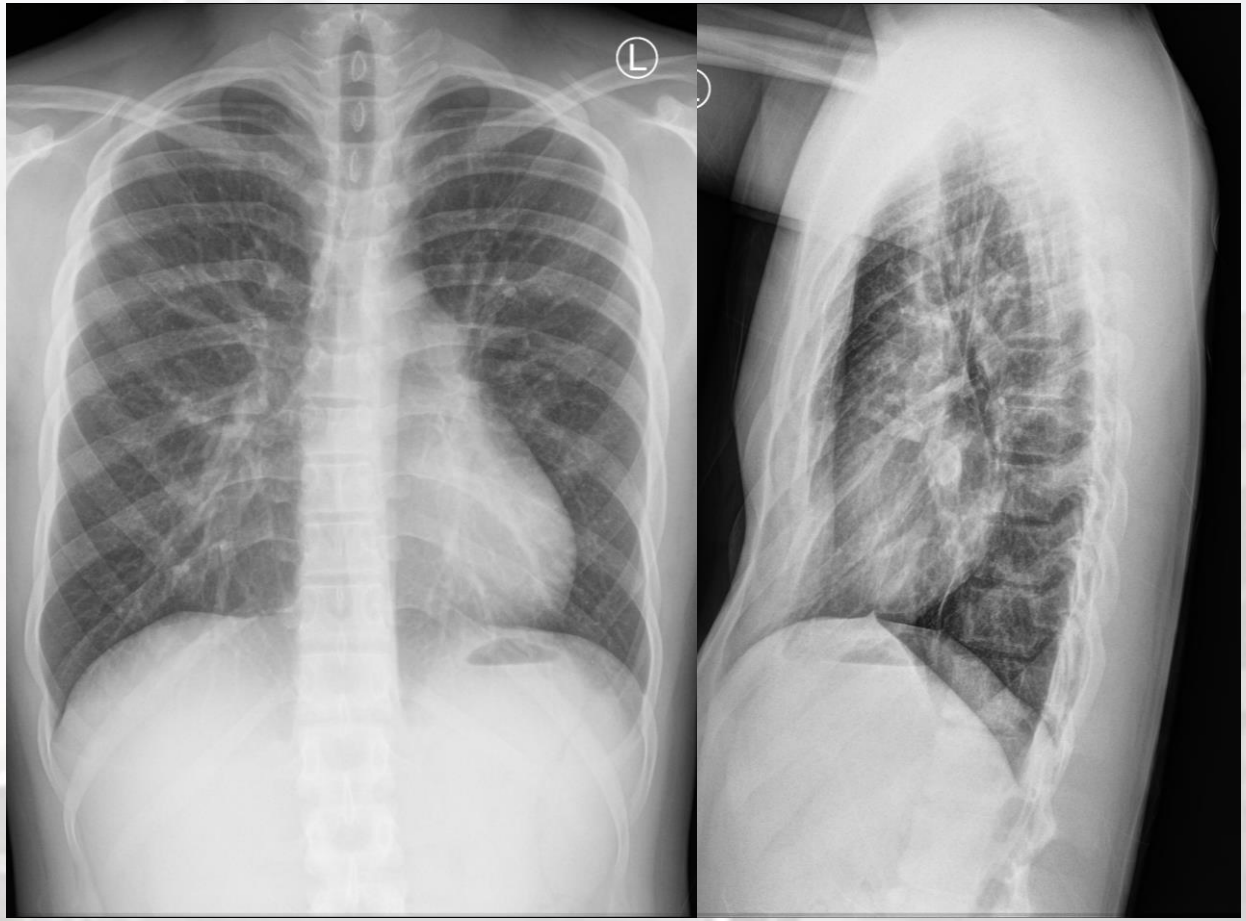
HI after applying VB; 3.0



Initial (2017) vs 2020

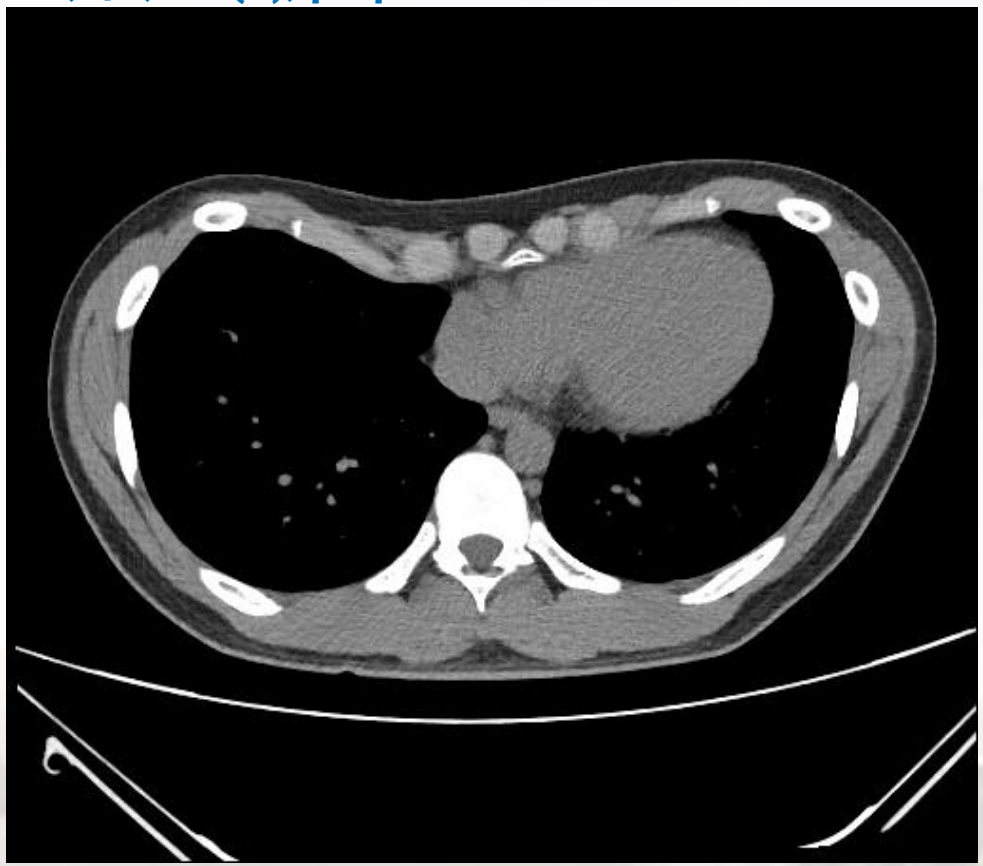
HI 3.5

HI 3.4



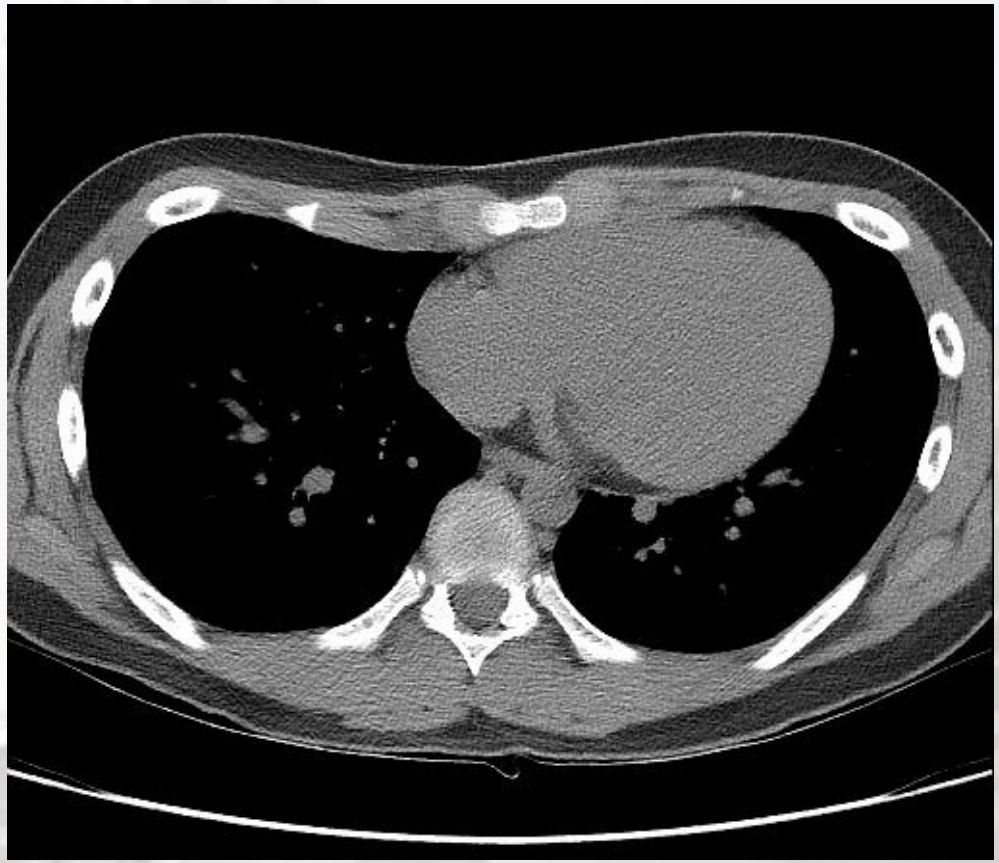
FU loss; 2023.07 → 수술 예정

HI; 4.1, Sx.(+); palpitation

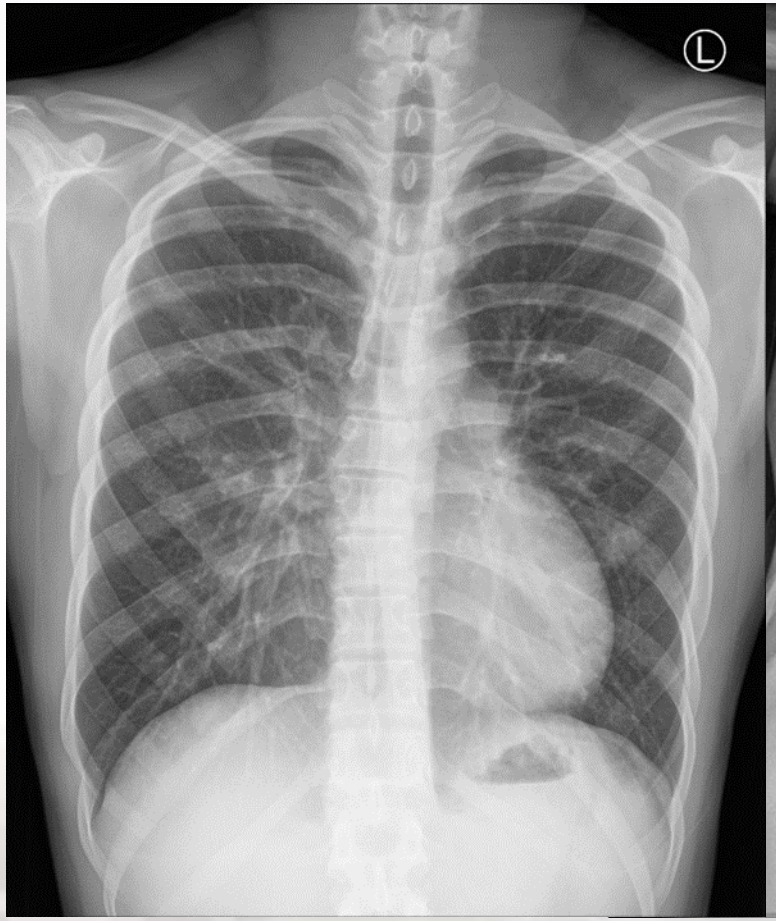
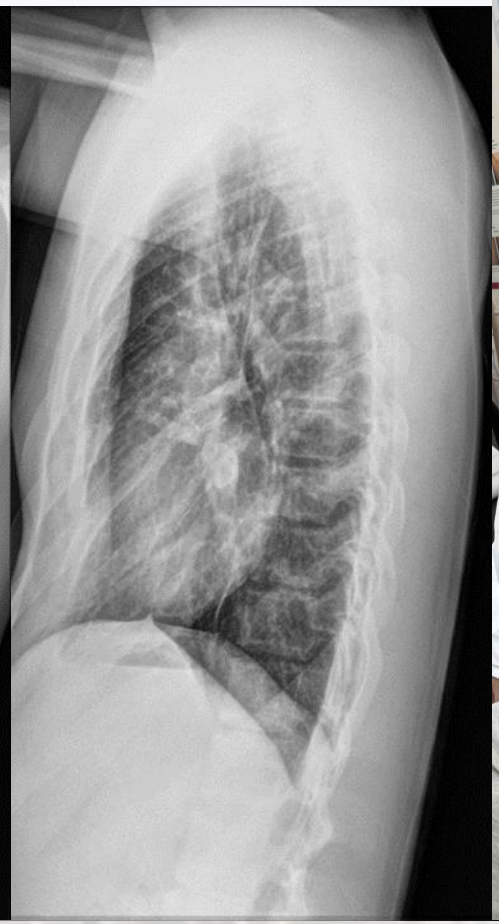


2023

HI before applying VB; 3.5



2017

Case 6; M/15

- Onset; 초 6

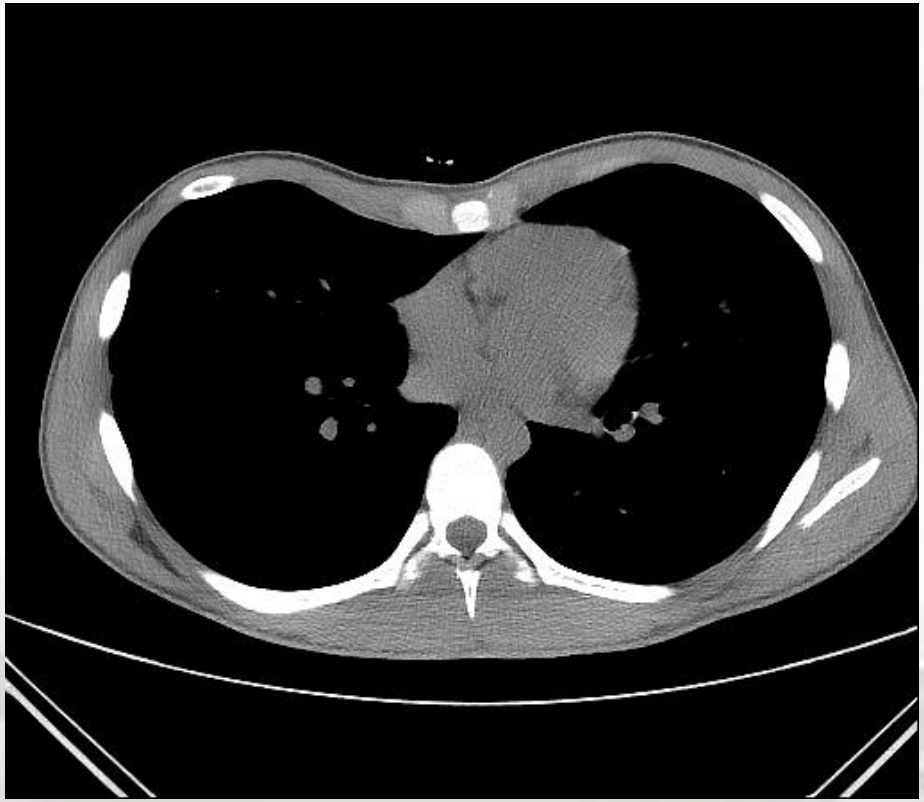
- Initial sternal depth; 3.2cm
- Post VB; 2.9cm

- Initial treatment plan; Op rec

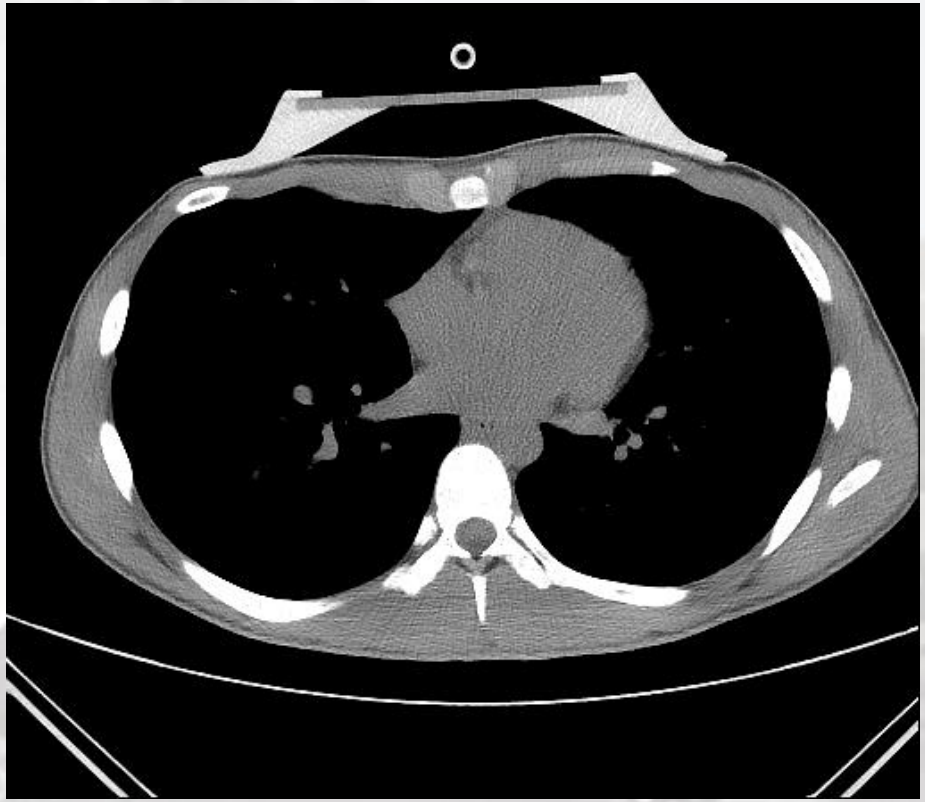
- 18-month FU; 2.6cm

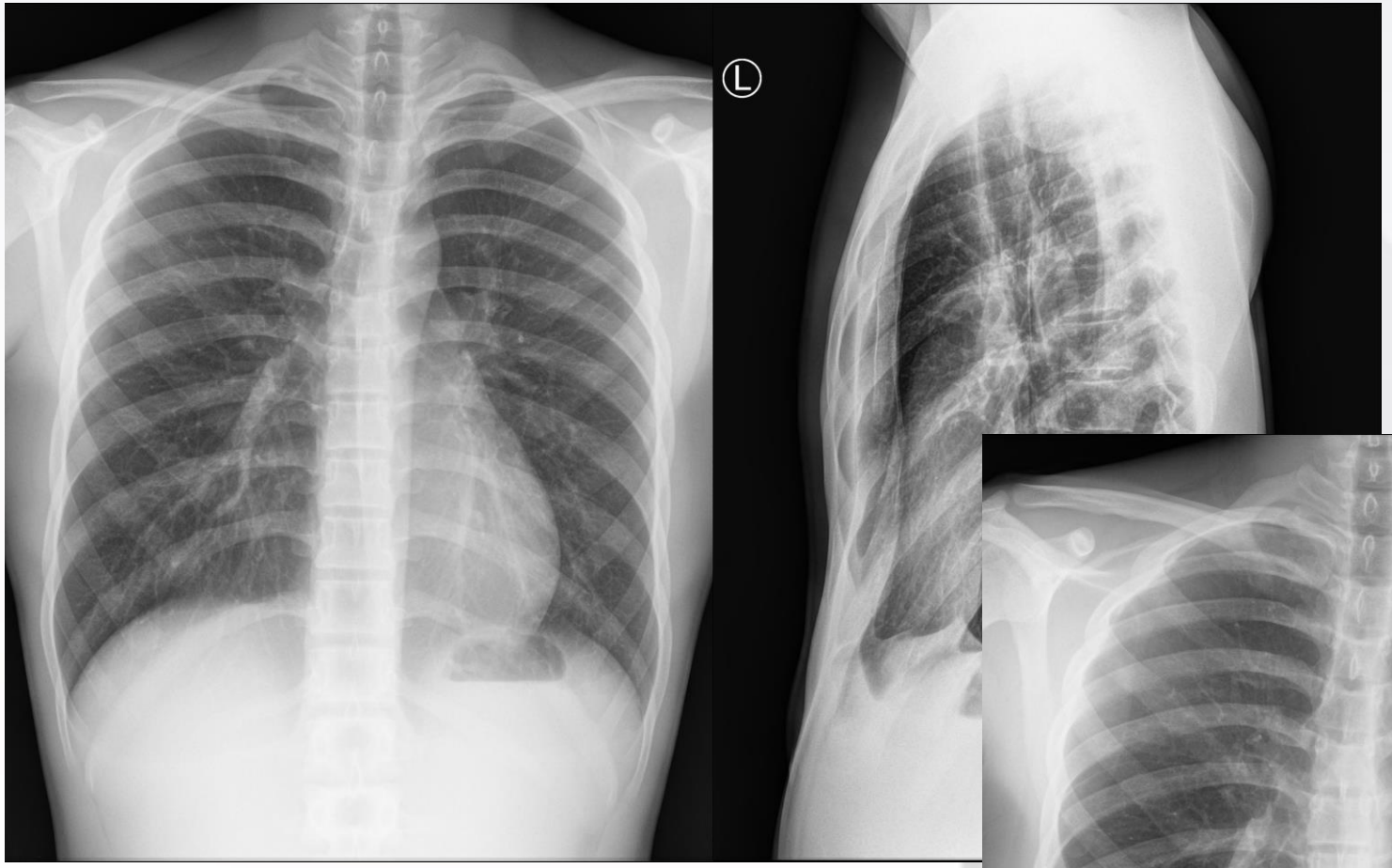
Pre-treatment measurement of HI

HI before applying VB; 3.4



HI after applying VB; 3.0



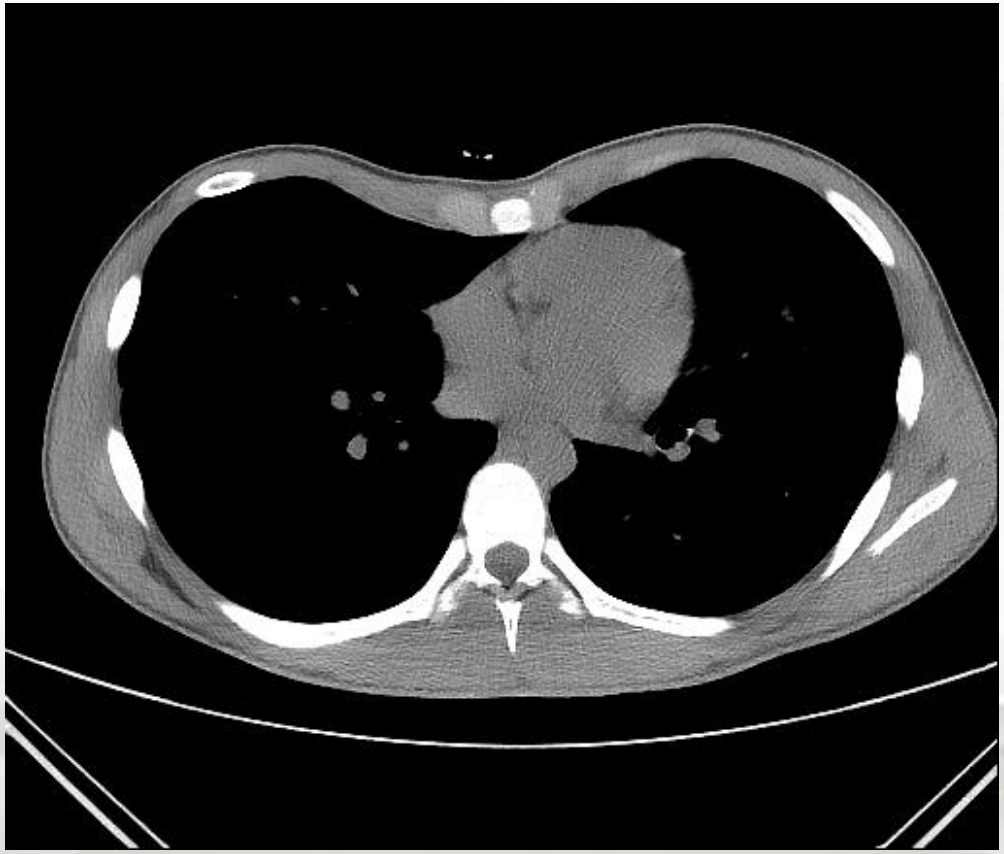


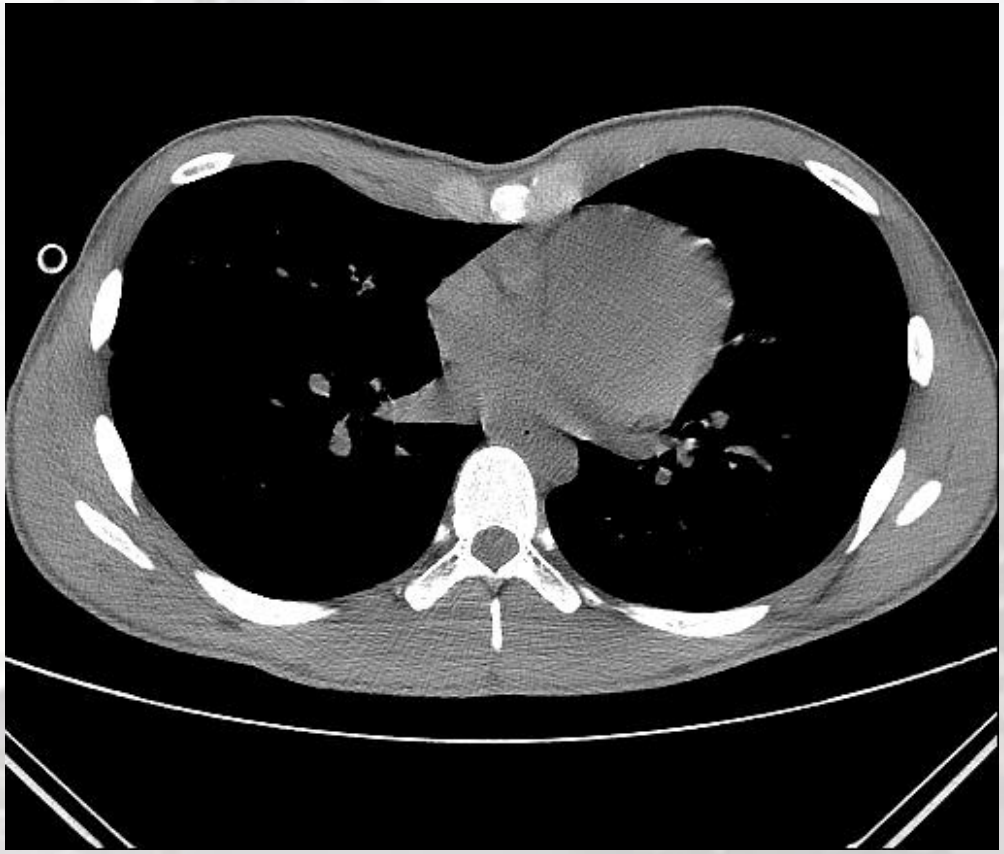
Initial

Post Vacuum bell

2018 vs 2020

HI; 3.4





Case 7; M/11

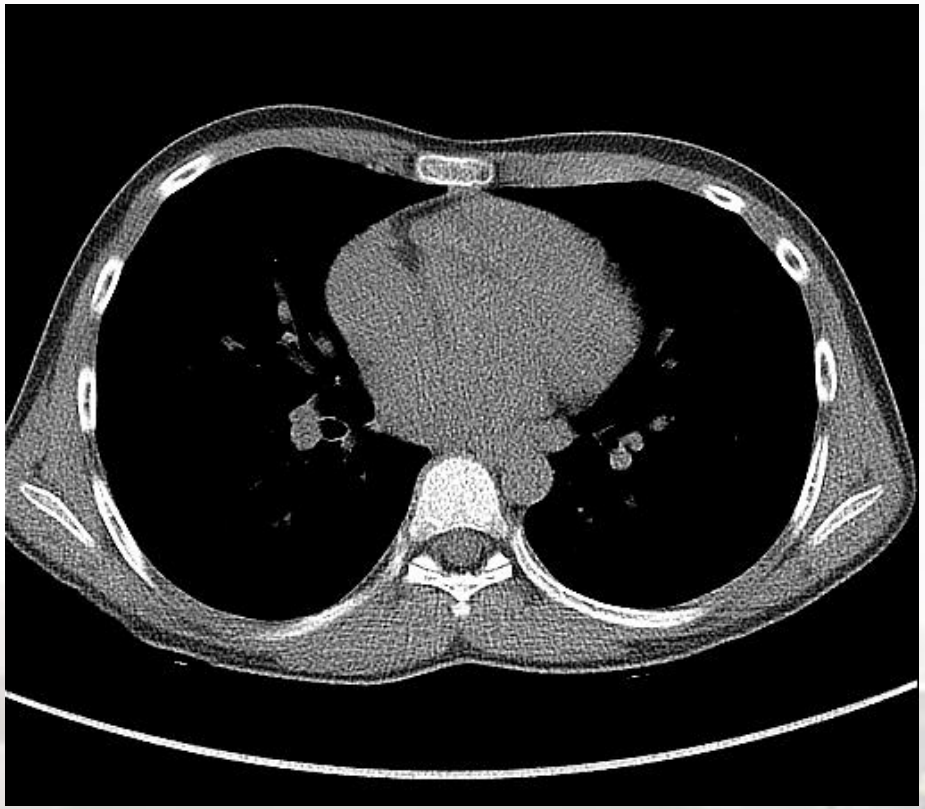
- Asymmetric

- Initial sternal depth; 2.5cm
- Post VB; 2.0cm

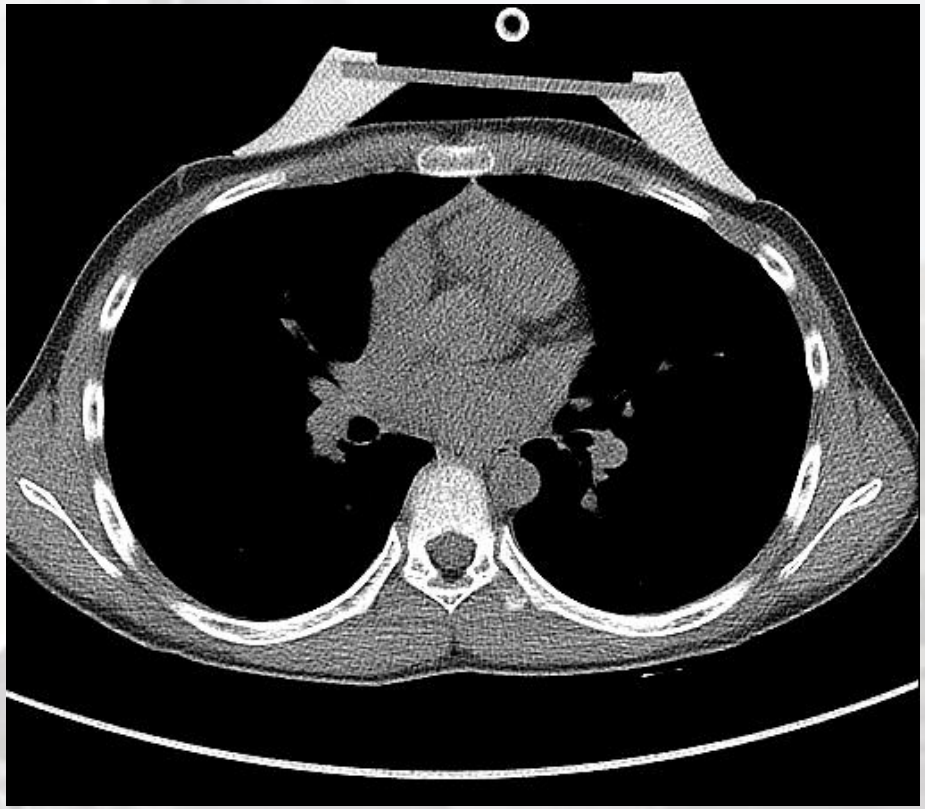
- 18-month FU; flat

Pre-treatment measurement of HI

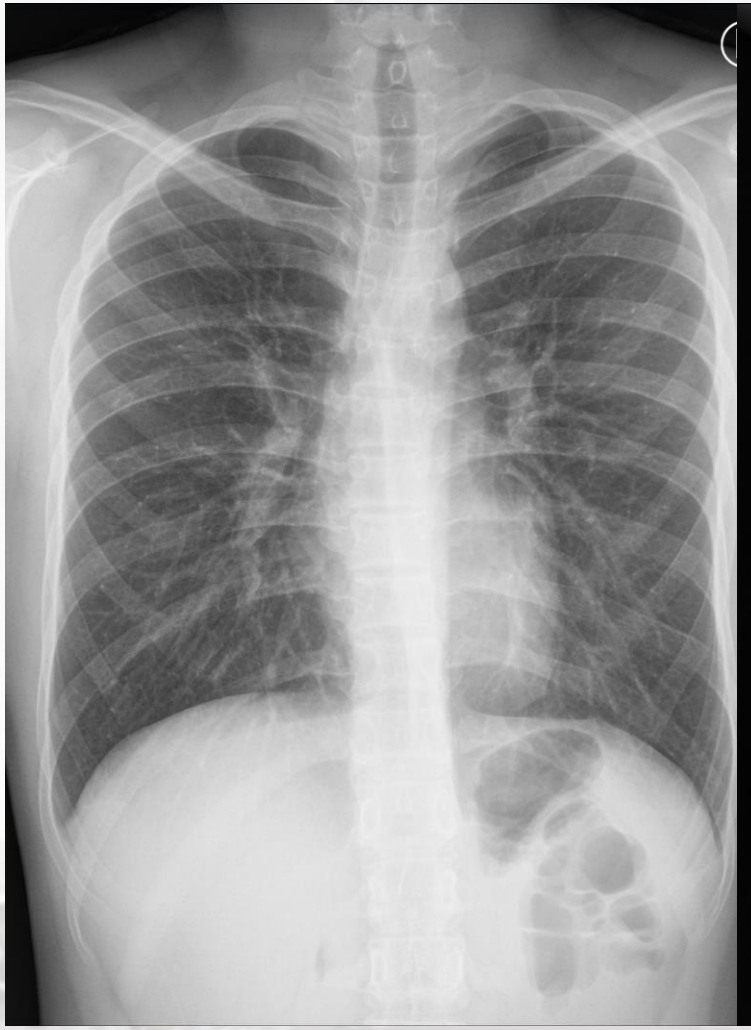
HI before applying VB; 2.8



HI after applying VB; 2.4



2019



HI 2.7

Clinical outcomes

- Schier *et al.* published short-term results of VBT on 60 patients in 2005 and about 20% were "corrected" after 5 months of treatment
- In 2011, Dr. Haecker published the first longer-term report demonstrating similar results with close to 13.5% being "corrected" after 18 months of VBT
- More recently in 2015 Lopez *et al.* reported a 31.5% rate of "correction", increasing to 37.5% when looking at a pediatric subgroup
- Complete "correction" of PE via VBT has been reported in the literature to range from 13.5–37.5%

Surgery after failed Vacuum bell therapy

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https://doi.org/10.1007/s00383-021-04963-6

ORIGINAL ARTICLE

Failed preoperative vacuum bell therapy does not affect outcomes following minimally invasive repair of pectus excavatum

J. L. Muff[1] · L. C. Guglielmetti[2] · S. J. Gros[1] · L. Buchmüller[1] · G. Frongia[3] · F.-M. Haecker[4,5] · S. G. Holland-Cunz[1] · T. de Trey[1] · Raphael N. Vuille-dit-Bille[1]

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Abstract

Purpose It is unknown if failed preoperative vacuum bell (VB) treatment in patients undergoing minimally invasive repair of pectus excavatum (MIRPE), delays repair and/or affects postoperative outcomes.

Methods A retrospective data analysis including all consecutive patients treated at one single institution undergoing MIRPE was performed between 2000 and 2016. Patients were stratified into preoperative VB therapy versus no previous VB therapy.

Results In total, 127 patients were included. Twenty-seven (21.3%) patients had preoperative VB treatment for 17 months (median, IQR 8–34). All 27 patients stopped VB treatment due to the lack of treatment effect. Eight (47.1%) of 17 assessed VB patients showed signs of skin irritation or hematoma. VB treatment had no effect on length of hospital stay ($p=0.385$), postoperative complications ($p=1.0$), bar dislocations ($p=1.0$), and duration of bar treatment ($p=0.174$). Time spent in intensive care unit was shorter in patients with VB therapy ($p=0.007$). Long-term perception of treatment including rating of primary operation ($p=0.113$), pain during primary operation ($p=0.838$), own perspective of look of chest ($p=0.545$), satisfaction with the procedure ($p=0.409$), and intention of doing surgery again ($p=1.0$) were not different between groups.

Conclusions Failed preoperative VB therapy had no or minimal effect on short-term outcomes and long-term perceptions following MIRPE.

Keywords Pectus excavatum · Minimal invasive repair of pectus excavatum · MIRPE · Nuss procedure · Vacuum bell therapy

Determinants of success associated with vacuum bell treatment of pectus excavatum☆

Luzia Toselli*, Emilio Chinni, Maximiliano Nazar-Peirano, Maxroxia Vallee, Daniela Sanjurjo, Jorge Martinez, Gaston Bellia-Munzon

Fundación Hospitalaria Mother and Child Medical Center, Av. Crámer 4602, Capital Federal, Buenos Aires, Argentina C1429AKL

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ABSTRACT

Background/Purpose: We explored determinants of success in a large cohort of patients with pectus excavatum submitted to vacuum bell treatment and compared groups with satisfactory versus unsatisfactory outcomes.

Methods: Retrospective case-control study in a single center between May 2013 and January 2020, including patients with pectus excavatum treated with vacuum bell. We classified patients according to their status at closure of data registry (surveillance; withdrawal; complete correction; failure) and according to Obermeyer's classification of degrees of pectus excavatum correction. Determinants of success were calculated using receiver operating characteristic curves.

Results: Overall, 186 patients were included. Complete correction was achieved by 17% of the cases, while 45% remained under surveillance. Failure rates were low ($n = 9$; 5%), whereas withdrawal rates were 34%. Based on Obermeyer's classification of degree of excavation correction, 35% had excellent/good, 25% fair, and 40% poor/worse results. When comparing patients with good/excellent results with those with unsatisfactory results, patients with good/excellent results had a longer treatment duration [19.0 (13.0; 28) months vs. 13.0 (6.5; 22.5) months, $p<0.0001$], and lower initial pectus depth [1.6 (1.2; 2.0) cm, vs. 2.0 (1.5; 2.6) cm, $p = 0.001$]. Using ROC curves, the best determinants of success were an initial pectus depth $\leq$ 1.8 cm and a length of treatment $>$ 12 months.

Conclusion: One-third of patients in treatment with a vacuum bell achieved excellent or good outcomes in our cohort. Determinants of success included an initial pectus depth of 1.8 cm or less and a minimum length of treatment of 12 months.

Type of study: retrospective comparative study
Level of evidence: III

Percentage Correction = [(Patient Initial Depth–Patient Current Depth) /(Patient Initial Depth–*Normal Depth*)] × 100; where *Normal Depth* = 0.51 cm.

Excellent (≥100%); Good (99%–67%); Fair (66%–34%); Poor (≤33%).

Conclusion

- **Proper candidates**
  - ✓Under 18 (≥ 12)
  - ✓Flexible chest
  - ✓Good compliance
  - ✓Min 30min BID to 2 hours
  - ✓Min 1-year
- **Clinical outcomes**
  - ✓Improvement; first a few months after start
  - ✓Complete correction rates; 13~37%
  - ✓Cx.; erythema, hematoma, rash, skin breakdown


Thank you for attention !!