Understanding and Managing Pectus Carinatum - Focusing on the Efficacy of Non-surgical Brace Therapy

Yong Ho Jeong,
Department of Thoracic and Cardiovascular Surgery, Gangnam Severance Hospital, Seoul, the Republic of Korea
Yonsei University College of Medicine

Introduction

Introduction

- **Pectus Carinatum**, often known as pigeon chest, is a condition characterized by a **protrusion of the sternum and ribs**.

- It is the second most common deformity of the chest wall after Pectus Excavatum.

- Results from an abnormal growth of the rib and sternum cartilage, leading to the outward projection of the chest wall.

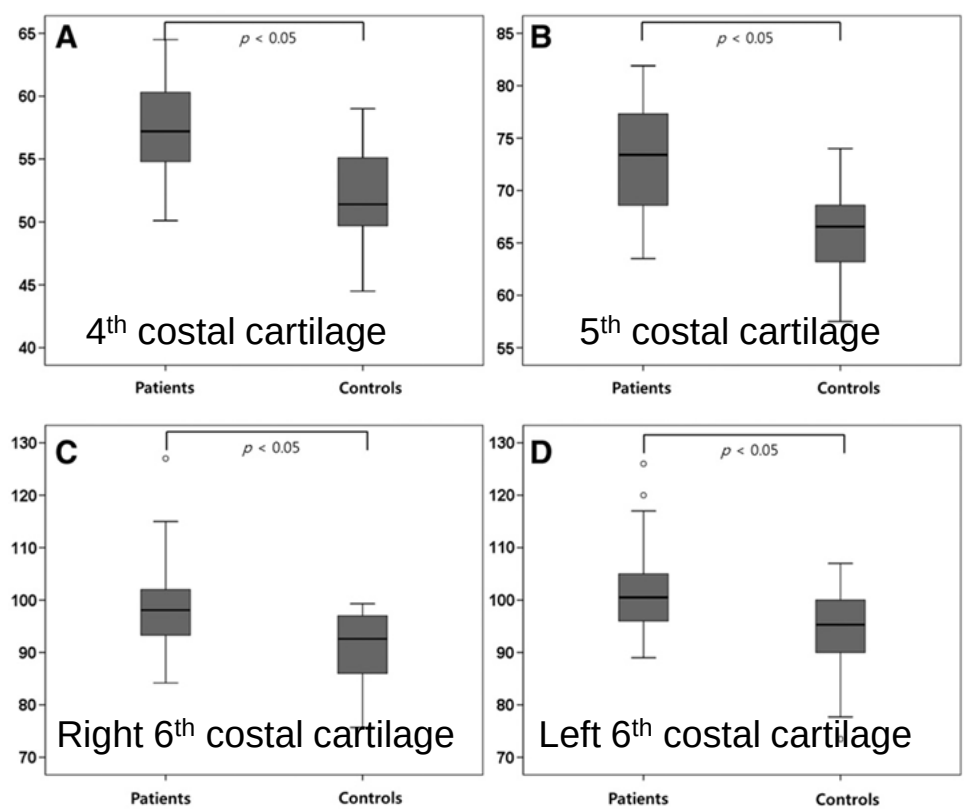
Etiology

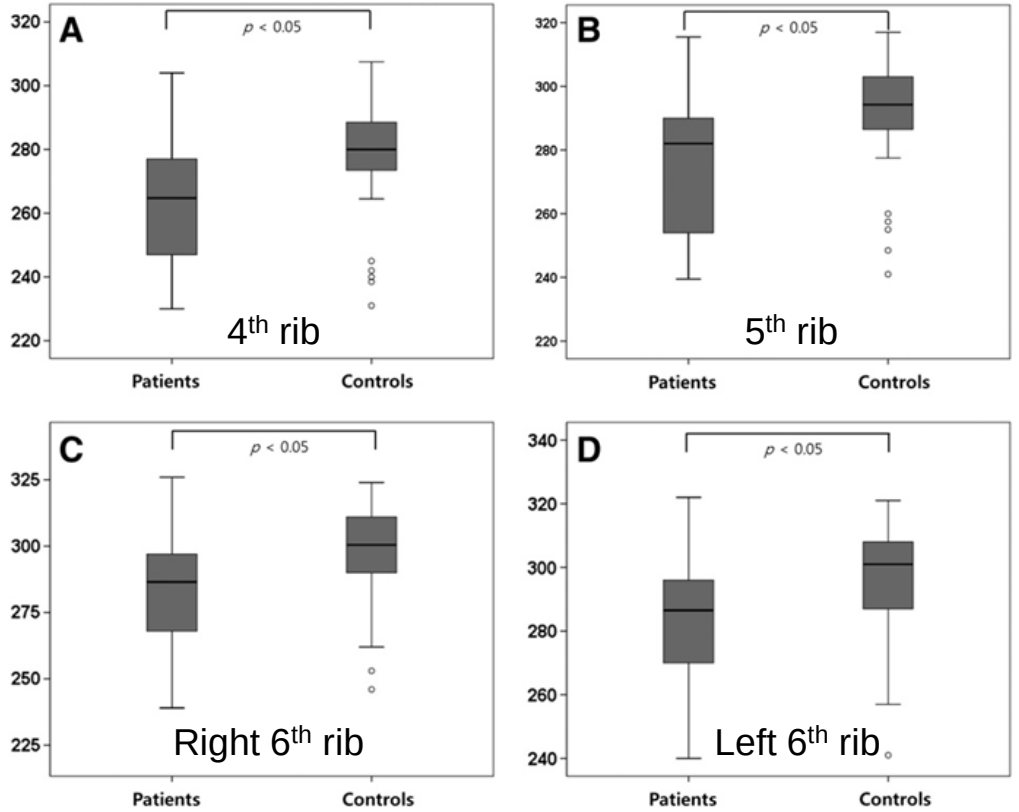
- Pectus carinatum often runs in families, suggesting a **hereditary component**.
  - Individuals with pectus carinatum frequently have relatives with similar chest wall deformities, including pectus excavatum.

- **Associated Genetic Syndromes**
  - Marfan Syndrome
  - Ehlers-Danlos Syndrome
  - Noonan Syndrome
  - Morquio Syndrome

Etiology

- Pectus carinatum : Shorter rib length and longer costal cartilage length





Park CH, et al. The etiology of pectus carinatum involves overgrowth of costal cartilage and undergrowth of ribs. J Pediatr Surg. 2014 Aug;49(8):1252-8. doi: 10.1016/j.jpedsurg.2014.02.044. Epub 2014 Feb 17. PMID: 25092085.

Epidemiology

- The prevalence is estimated to be around **1 in 1,500 to 1 in 1,000 individuals**.

- **Higher incidence in males** than in females
  - Male-to-female ratio of approximately 4:1

- The condition is more noticeable during periods of rapid growth and can vary in severity.

Clinical Manifestation

- **Physical Symptoms**
  - Visible Deformity
  - Chest Pain

- **Functional Symptoms**
  - Shortness of Breath
  - Reduced Exercise Tolerance
  - Cardiovascular Symptoms

Clinical Manifestations

- **Psychosocial Symptoms**
  - **Self-Esteem** and Body Image Issues
    - Significant distress, particularly in **adolescents and young adults**
    - Decreased self-esteem and body image issues
  - **Social Anxiety**
    - Social withdrawal and anxiety
    - **Avoidance of activities that expose the chest**, such as swimming or changing clothes in public.

- Associated Conditions and Symptoms
  - Scoliosis
    - Higher incidence of scoliosis in individuals with pectus carinatum

Diagnosis

- **Physical examination**
  - Characteristic protrusion of the chest
  - Medical history, including any family history of chest wall deformities
  - Associated symptoms

- **Chest X-ray**
  - Lateral chest X-rays can provide a clearer view of the protrusion's severity.

- Computed Tomography (CT) Scan
  - Particularly useful in planning surgical interventions

- Magnetic Resonance Imaging (MRI)
  - May be important in complex cases or when additional thoracic anomalies are suspected.

Indications for Treatment

- **Physical Indications**
  - Moderate to Severe Protrusion
  - Asymmetry

- Associated Musculoskeletal Abnormalities
  - Scoliosis : May worsen the chest wall deformity or be exacerbated by it.
  - Postural Issues : Abnormal posture related to compensating for the chest protrusion.

Indications for Treatment

- **Psychosocial Indications**
  - **Body Image Issues**: Significant distress about appearance, leading to low self-esteem, anxiety, or depression.
  - **Social Withdrawal**: Avoidance of social situations or activities that might expose the chest, such as swimming or changing in locker rooms.

- Quality of Life
  - Impaired Daily Activities: Difficulty performing daily tasks or participating in sports

- Patient and Family Preferences
  - Desire for Cosmetic Improvement
  - Readiness for Treatment

History of Bracing Therapy for Pectus Carinatum

Bracing Therapy for Pectus Carinatum

- **Most effective non-surgical treatment**

- Effective in growing Children and Adolescents
  - Ideal candidates are those who are still growing
  - The chest wall is more malleable, making bracing more effective.

- Mild to Moderate Deformity

- Physical therapy could be added to bracing therapy for better correction
  - Building up muscle may help disguise the deformity

History of Bracing Therapy

- **First case report**
  - C H Mielke and R B Winter
  - Mayo Clinic published a case report in 1993.
  - 14 year old girl
  - Seven years follow up with excellent results and no recurrence

History of Bracing Therapy

- **First report in Korea**

European Journal of Cardio-thoracic Surgery 34 (2008) 146—149

www.else

Effect of the compressive brace in pectus carinatum

Seock Yeol Lee*, Seung Jin Lee, Cheol Woo Jeon,
Cheol Sae Lee, Kihl Rho Lee

Department of Thoracic & Cardiovascular Surgery, Soonchunhyang University Cheonan Hospital,
23 Bongmyung-dong, Cheonan-city, South Korea

Bracing Therapy at Soonchunhyang University Cheonan Hospital

- Period
  - January 2001 - December 2007
- Location
  - Soonchunhyang University Cheonan Hospital, South Korea
- Participants
  - 119 compliant patients with pectus carinatum
- Objective
  - Evaluate the effectiveness and efficiency of compressive brace therapy

Bracing Therapy at Soonchunhyang University Cheonan Hospital

- Wearing Protocol
  - 24 hours a day, with exercise recommendations (deep breathing, weightlifting, pectoralis exercises) for 6 months

- Satisfaction Scores
  - Score 1 to 4
  - Mean Satisfaction: 3.95 ± 0.4

- Recurrence
  - 6 patients (5.0%) experienced recurrence, all re-corrected with brace reapplication .

Bracing Therapy at Soonchunhyang University Cheonan Hospital

- Weaning Off the Brace
  - Procedure: Gradual reduction in wearing time over 2-3 months
- Follow-Up
  - No abrupt weaning, monitored for recurrence
- Effectiveness
  - Majority successfully weaned off without long-term issues

Bracing Therapy at Soonchunhyang University Cheonan Hospital

- Effectiveness
  - Compressive brace is effective, especially in children and teenagers.
- Advantages
  - Non-surgical option for those avoiding surgery due to fear of anesthesia and complications
- Future Research
  - Long-term follow-up required to evaluate recurrence and effectiveness

Bracing Therapy at Gangnam Severance Hospital

Long-Term Results of Compressive Brace Therapy for Pectus Carinatum

Duk Hwan Moon[1] Min Kyun Kang[1] Hye Sun Lee[2] Sungsoo Lee[1]

[1] Department of Thoracic and Cardiovascular Surgery, Gangnam Severance Hospital, Seoul, the Republic of Korea
[2] Biostatistics Collaboration Unit, Gangnam Severance Hospital, Seoul, the Republic of Korea

Address for correspondence Sungsoo Lee, Department of Thoracic and Cardiovascular Surgery, Gangnam Severance Hospital, 211 Eonju-ro, Gangnam-Gu, Seoul 06273, the Republic of Korea (e-mail: CHESTLEE@yuhs.ac).

Thorac Cardiovasc Surg 2019;67:67–72.

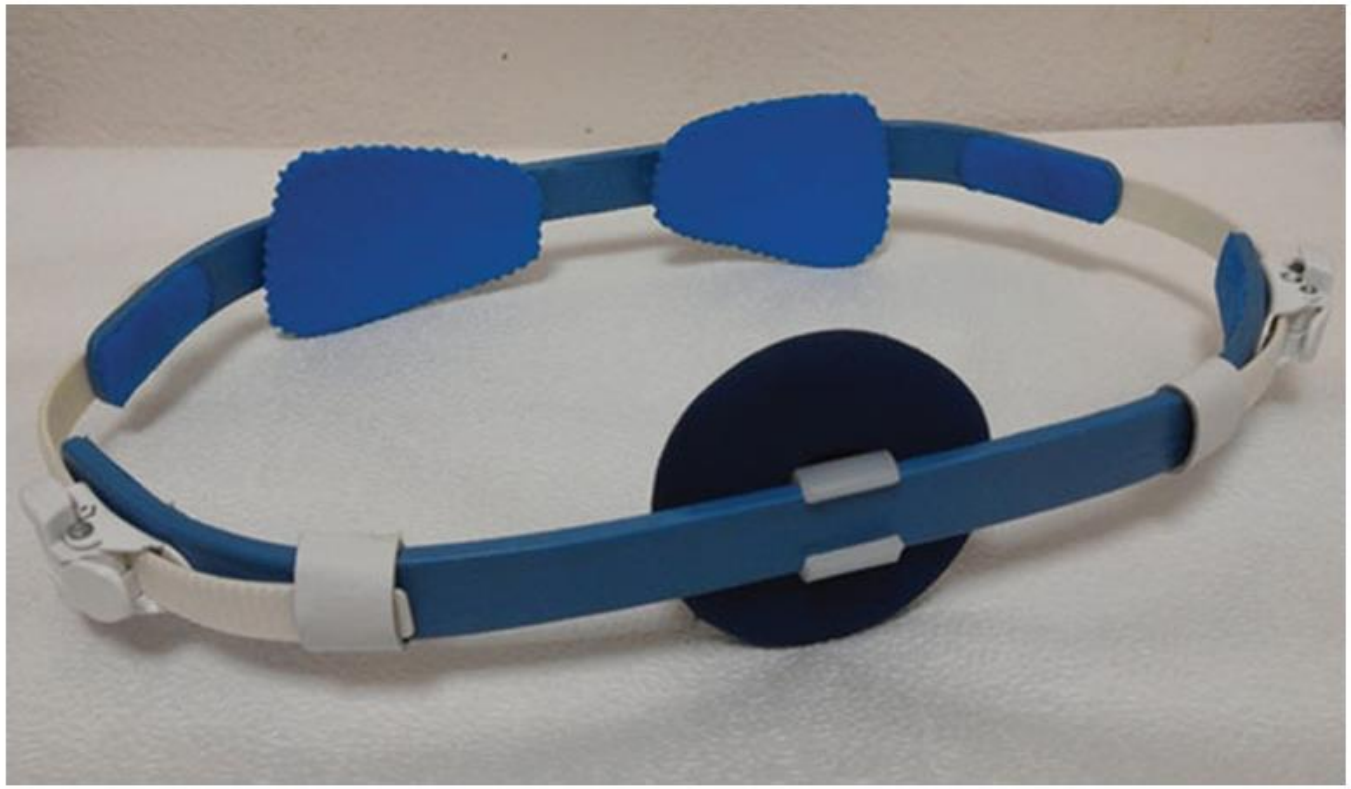
Bracing Therapy at Gangnam Severance Hospital

- Study population
  - Period : January 2014 ~ December 2016
  - 320 patients were enrolled

- Brace therapy protocol
  - Manual reduction test prior to brace therapy
  - Initial 2 weeks compression period : 20 hours per day
  - 6 months maintenance period : 12 hours per day

Bracing Therapy at Gangnam Severance Hospital

Lee RT, et al. Bracing is an effective therapy for pectus carinatum: interim results. J Pediatr Surg. 2013 Jan;48(1):184-90. doi: 10.1016/j.jpedsurg.2012.10.037. PMID: 23331813.

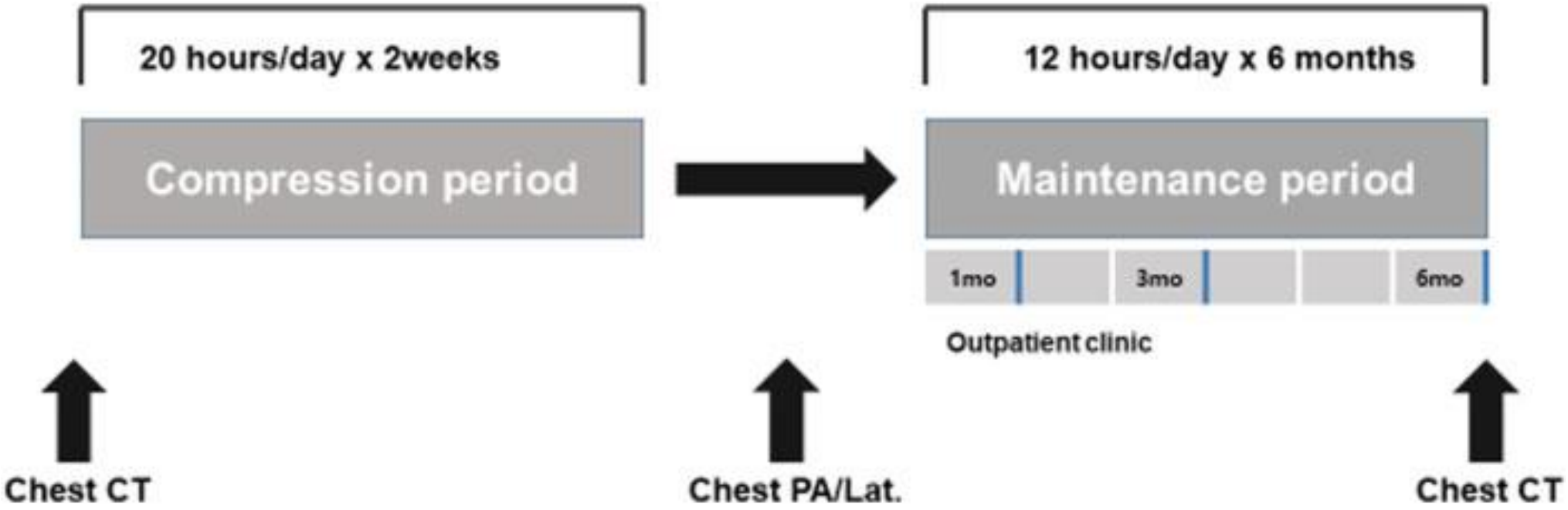


Kang DY, et al. Factors affecting patient compliance with compressive brace therapy for pectus carinatum. Interact Cardiovasc Thorac Surg. 2014 Dec;19(6):900-3. doi: 10.1093/icvts/ivu280. Epub 2014 Aug 27. PMID: 25164133.

Bracing Therapy at Gangnam Severance Hospital

- Custom-fitted, adjustable compression braces made of aluminum, sponge, and plastic.
- Buckles on the braces allow the patient to modify the correction power by adjusting the gradation on the buckle (blue arrow).
- Circular compression plate (red arrow) can easily be adjusted into a new position.

Bracing Therapy at Gangnam Severance Hospital



Bracing Therapy at Gangnam Severance Hospital

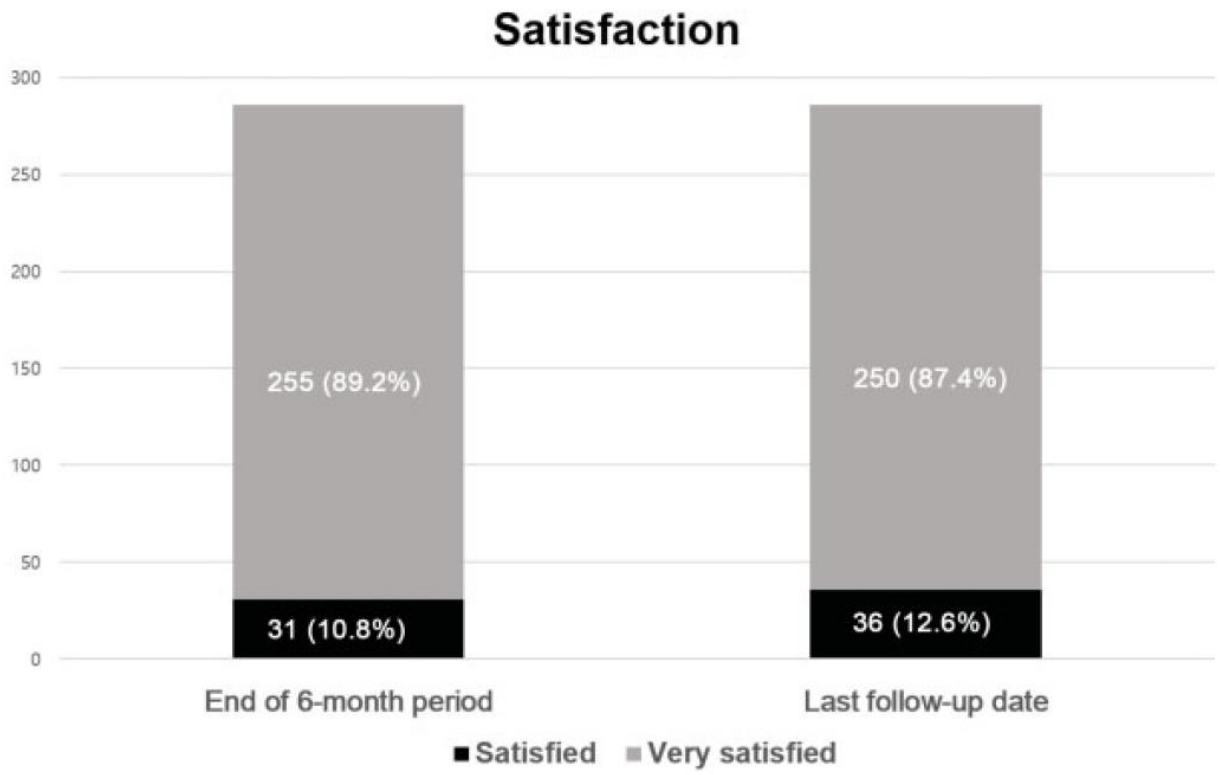
- Patient characteristics

Characteristics	Total ($n = 320$)
Age, years	13 (2–33)
Male	280 (87.5%)
Family history of pectus carinatum	
No	253 (79.1%)
Yes	67 (20.9%)
Pectus carinatum symmetry	
Symmetric pectus carinatum	168 (52.5%)
Asymmetric pectus carinatum	152 (47.5%)
Compliance	
Compliance group	286 (89.4%)
Noncompliance group	34 (10.6%)

Group	Compliance	Overall p Value
I (1–5 years), $n = 28$	24 (85.7%)	0.008
II (6–10 years), $n = 44$	43 (97.7%)	
III (11–15 years), $n = 208$	189 (90.9%)	
IV (16–20 years), $n = 29$	21 (72.4%)	
V ($\geq$20 years), $n = 11$	9 (81.8%)	

Bracing Therapy at Gangnam Severance Hospital

- Satisfaction after brace therapy in the compliance group



Bracing Therapy at Gangnam Severance Hospital

- Satisfaction after brace therapy in the compliance group

Satisfaction	6-Month	Last follow-up	Satisfaction grade difference	*p* Value
Satisfied	31 (10.8%)	36 (12.6%)	−0.003 ± 0.003	0.328
Very satisfied	255 (89.2%)	250 (87.4%)		

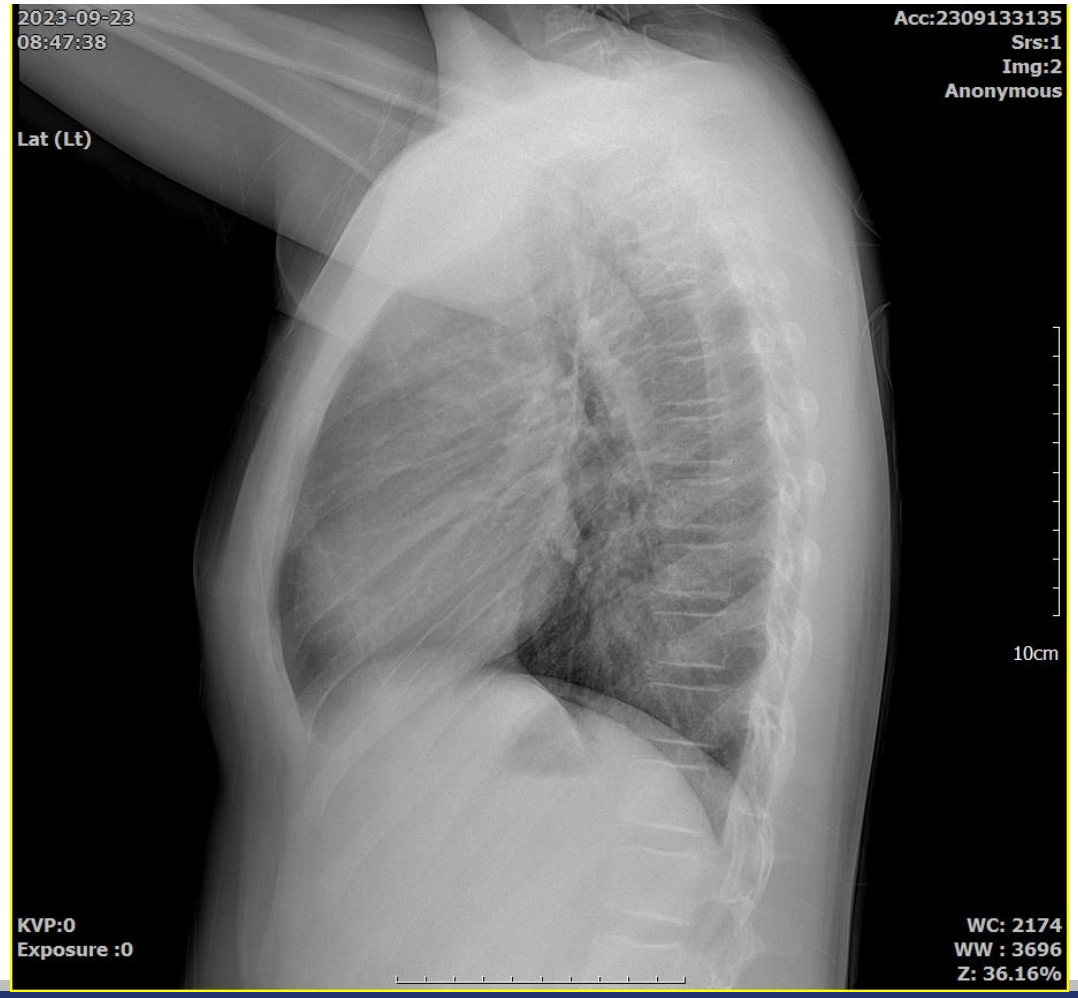
Bracing Therapy at Gangnam Severance Hospital

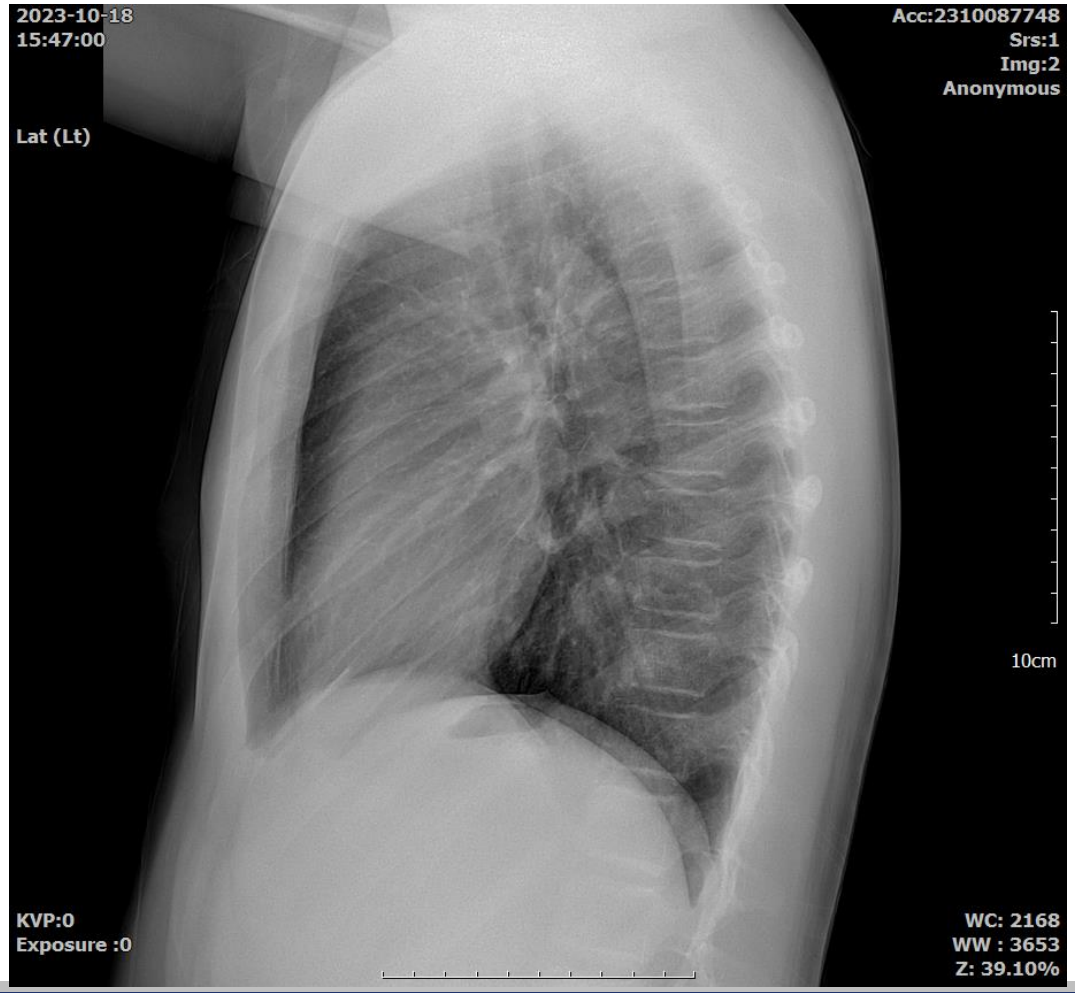
- Satisfaction between the 6-month mark and last follow-up using linear mixed model according to age

	6-Month	Last follow-up	Satisfaction grade difference	*p* Value
Group I, $n = 24$			0.013 ± 0.018	0.476
Satisfied	4 (16.7%)	4 (16.7%)		
Very satisfied	20 (83.3%)	20 (83.3%)		
Group II, $n = 43$			-0.001 ± 0.011	0.872
Satisfied	6 (14.0%)	7 (16.3%)		
Very satisfied	37 (86.0%)	36 (83.7%)		
Group III, $n = 189$			-0.003 ± 0.004	0.482
Satisfied	21 (11.1%)	25 (13.2%)		
Very satisfied	168 (88.9%)	164 (86.8%)		
Group IV				
Satisfied	0 (0)	0 (0)		
Very satisfied	21 (100%)	21 (100%)		
Group V				
Satisfied	0 (0)	0 (0)		
Very satisfied	9 (100%)	9 (100%)		

Bracing Therapy at Gangnam Severance Hospital

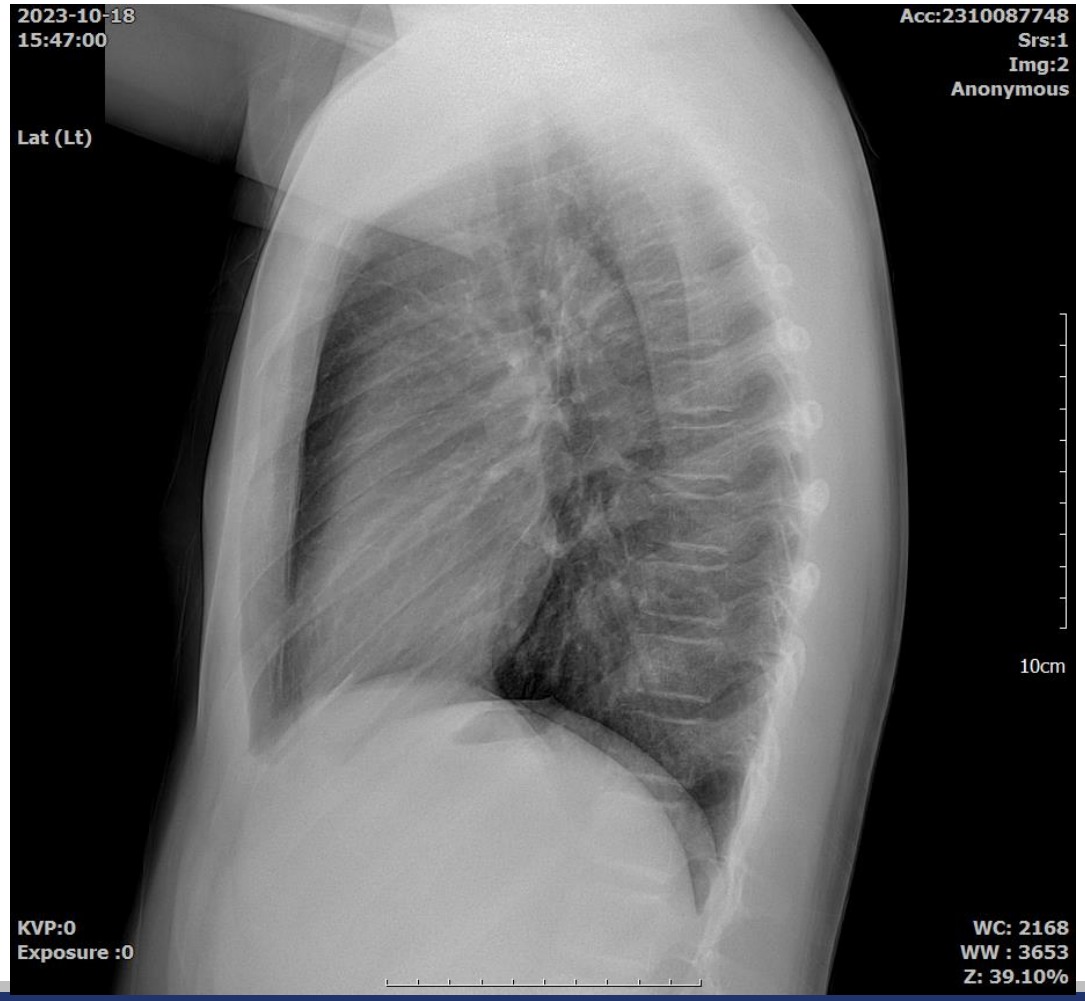
- Serial chest X-rays of well treated patient





Bracing Therapy at Gangnam Severance Hospital

- Serial chest X-rays of well treated patient



Bracing Therapy at Gangnam Severance Hospital

- Serial chest X-rays of well treated patient

Bracing Therapy at Gangnam Severance Hospital

- Most frequent reason for noncompliance was the concern of appearance while wearing the brace, followed by pain and discomfort.
  - It is important to consider the aesthetic and design aspects for better compliance

- Good rapport with the patients through the outpatient clinic is essential
  - Complimenting progress, emotional support, and careful instructions could lead to better compliance
  - Detailed feedback for brace-related discomfort is essential

Recent Research on Bracing Therapy

Congenital & Pediatric: Research

Ravitch Surgery or Dynamic Compression Bracing for Pectus Carinatum: A Retrospective Cohort Study

Hendrik van Braak, BS,[1] Sjoerd A. de Beer, MD,[1] Sander Zwaveling, MD, PhD,[1] Matthijs W. N. Oomen, MD, PhD,[1] and Justin R. de Jong, MD, PhD[1]

(Ann Thorac Surg 2024;117:144-52)

Recent Research on Bracing Therapy

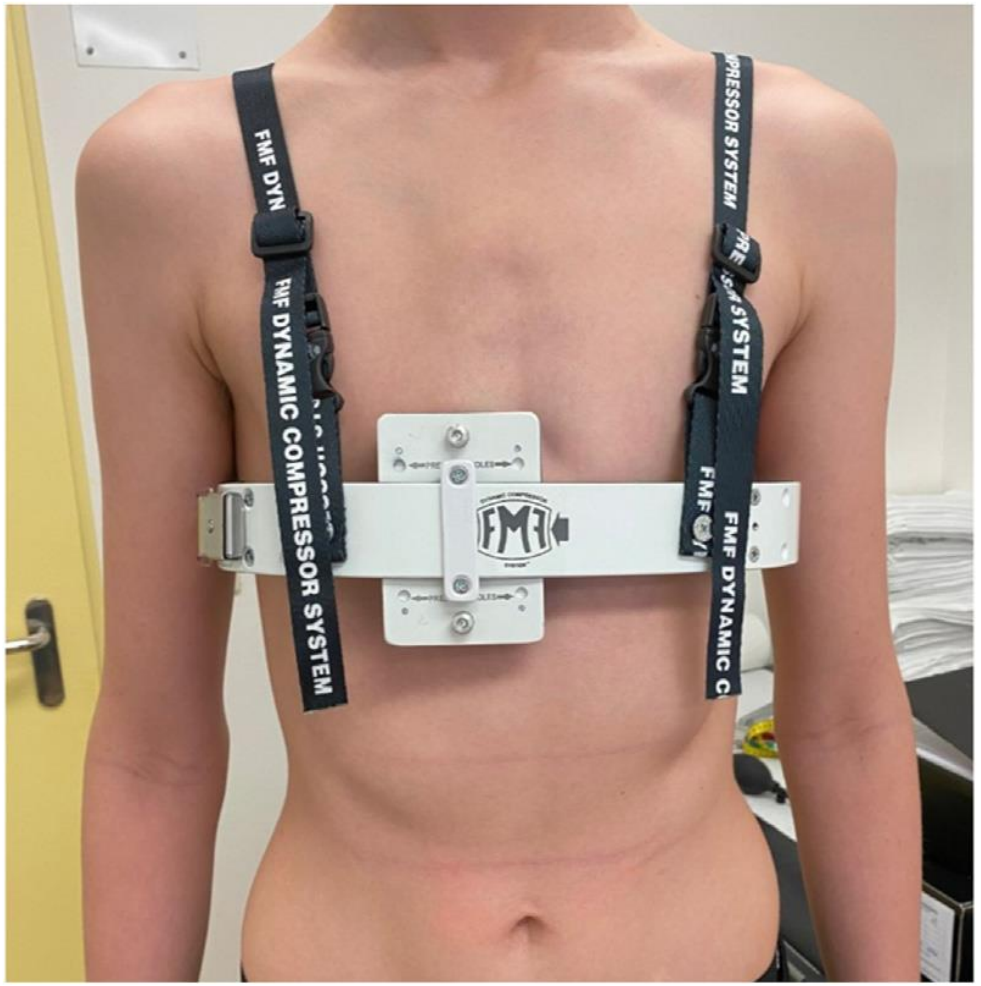
- Study Design
  - Retrospective cohort study
- Period : January 2009 – December 2019
- Participants
  - 738 patients (age 0-18 years) treated at Amsterdam Pectus Center
- Data Collection
  - Electronic medical records, patient follow-up

Recent Research on Bracing Therapy

- Dynamic compression bracing
  - Total Patients: 631
  - Completed Treatment: 553
  - Success Rate: 73.8%
  - Failure Rate: 13.6%
  - Lost to Follow-up: 12.7%

- Ravitch Surgery
  - Total Patients: 105
  - Success Rate: 92.4%
  - Complication Rate: 32.4%
  - Complications Requiring Surgery: 6.7%

- Abramson Procedure : 2


FMF DYNAMIC COMPRESSOR SYSTEM
FMF DYNAMIC COMPRESSOR SYSTEM

Recent Research on Bracing Therapy

- Dynamic compression bracing
  - Total Patients: 631
  - Completed Treatment: 553
  - Success Rate: 73.8%
  - Failure Rate: 13.6%
  - Lost to Follow-up: 12.7%

- Ravitch Surgery
  - Total Patients: 105
  - Success Rate: 92.4%
  - Complication Rate: 32.4%
  - Complications Requiring Surgery: 6.7%

Recent Research on Bracing Therapy

- Dynamic compression bracing success rates
  - Higher success with lower initial pressure (<5.0 psi) : 84.2%
  - Lower success with higher initial pressure (>7.5 psi) : 67.3%
  - Complications: Minimal, primarily minor skin lesions

- Dynamic compression bracing advantages
  - Preferred due to non-invasiveness, lower complication rates
  - Discouraged before growth spurt

- Consideration for Dynamic compression bracing success
  - Patient motivation and compliance critical for success

Summary

Summary

- Compressive brace therapy for pectus carinatum is a simple, safe, and effective treatment with good long-term outcomes.

- High compliance and satisfaction rates support use of brace as a first-line treatment.

YONSEI UNIVERSITY
COLLEGE OF MEDICINE