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Non-operative Treatment of Pectus Excavatum and Carinatum: A Retrospective Analysis

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What is known on this subject?

Pectus excavatum and pectus carinatum are the most common congenital chest wall deformities. Non-surgical treatments such as vacuum bell therapy and bracing have been increasingly used, especially in pediatric populations. These deformities can have significant cosmetic, psychosocial, and functional impacts.

What this study adds?

This study presents real-life clinical outcomes from a single center with a large patient series using non-surgical treatment methods. It demonstrates high success rates, particularly in patients who begin therapy early. The findings support the effectiveness and tolerability of vacuum and bracing methods as viable, non-invasive alternatives to surgery. Due to the retrospective nature of the study, no imaging was used other than routinely performed posteroanterior chest X-rays; the evaluation was conducted through physical examination and measurements. This approach helped avoid additional costs and unnecessary radiation exposure. It emphasizes the need for more extensive, local data from different populations to support treatment guidelines.

ABSTRACT

Objective: Pectus deformities are conditions characterized by abnormal development of the ribs, cartilage, and sternum that form the chest wall. The most common types, pectus excavatum (PE) and pectus carinatum (PC), can lead to functional, orthopedic, and psychological problems. This study aims to evaluate the effectiveness of non-surgical treatment methods for these deformities in a pediatric population.

Material and Methods: This retrospective study included 112 patients diagnosed with PE, PC, or mixed-type deformities between June 2021 and February 2025. Patients were treated with vacuum bell therapy or compressive bracing depending on the deformity type. Treatment adherence, deformity depth/height, and subjective cosmetic improvement were assessed. Clinical outcomes were compared by evaluating pre- and post-treatment measurements in relation to treatment compliance.

Results: The mean age of patients was 11.6 years (range: 6-18). Among PE patients, the mean sternal depth decreased from 2.5±0.7 cm to 1.4±0.6 cm in patients with good adherence ($p<0.01$). In PC patients, deformity height reduced from 1.9±0.5 cm to 1.3±0.4 cm with consistent bracing ($p=0.032$). None of the patients required surgery. Adherence and early treatment initiation were associated with better outcomes.

Conclusion: Non-surgical treatments, including vacuum bell therapy and compression bracing, showed improvement in deformity measurements in pediatric patients with PE and PC who demonstrated good treatment adherence. These findings support the effectiveness of these methods, but further studies are needed to confirm long-term outcomes.

Keywords: Pectus excavatum, pectus carinatum, vacuum bell therapy and bracing, non surgical treatment

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Introduction

Pectus deformities are congenital anomalies caused by abnormal development of the sternum, costal cartilages, and ribs, resulting in deformities of the anterior chest wall. The most common types are pectus excavatum (PE) and pectus carinatum (PC), together accounting for over 90% of congenital chest wall deformities (1). PE, also known as "funnel chest", makes up approximately 88% of these cases and is characterized by inward displacement of the sternum. Patients often report symptoms such as dyspnea, fatigue during exertion, and psychosocial distress due to poor body image (2). In contrast, PC involves an outward protrusion of the chest wall and is often less symptomatic but still causes significant aesthetic and psychological issues (3).

In recent years, non-surgical treatment methods, particularly vacuum bell therapy for PE and custom-fitted bracing for PC, have gained popularity as less invasive alternatives to surgery, showing promising clinical outcomes (4,5,6). These methods are particularly effective when applied during early adolescence, a period of greater chest wall pliability. However, there has been no comprehensive study previously conducted in our region or center demonstrating such effective use and evaluation of these treatment methods. Despite being a single center, our relatively large number of patients increases the significance of this study.

This study aims to demonstrate the applicability and effectiveness of these treatment methods at a local level.

Our hypothesis is that non-surgical treatment methods lead to a significant reduction in deformity depth/height in pediatric patients with pectus deformities.

Material and Methods

This retrospective, single-center study included patients diagnosed with PE, PC, or mixed-type deformities who presented to a tertiary care facility between June 2021 and February 2025. The study was approved by the Ethics Committee of Ordu University with the decision number 2024/54 at the meeting held on June 7, 2024.

Patients aged between 5 and 18 years diagnosed with PE, PC, or mixed-type deformity who initiated and completed at least 6 months of non-surgical treatment were included in the study. Patients with incomplete follow-up data, those who discontinued treatment before 6 months, or those with co-existing thoracic skeletal syndromes were excluded from the analysis.

Initially, a total of 130 patients were included in the study. However, only 112 patients actively continued or completed the treatment and were included in the analysis. Patients who did not complete the treatment were excluded from the study.

Patient data were obtained from the hospital automation system and outpatient clinic records. The following parameters were evaluated: diagnosis (PE or PC), age and gender, deformity symmetry (symmetric/asymmetric), physical depth/height of the deformity (measured in centimeters), average daily vacuum bell and custom-designed compressive bracing usage time (hours), total treatment duration (months), treatment compliance (categorized as good, moderate, or poor based on average daily usage: ≥2 hours/day for PE and ≥16 hours/day for PC), subjective improvement in appearance (based on hospital observations and patient/parent reports), adverse events related to treatment (skin lesions, pain, etc.).

As imaging modalities such as chest computed tomography (CT), Haller index (HI), or correction index measurements were not routinely performed, evaluations relied solely on physical examination findings and direct deformity measurements using a tape measure at baseline and follow-up visits.

Statistical Analysis

Descriptive statistics including mean, standard deviation, median, percentage, minimum, and maximum values were used for data analysis. Normality of distribution was assessed using the Shapiro-Wilk test. Comparisons between two groups utilized Student's t-test for normally distributed variables and Mann-Whitney U test for non-normally distributed variables. Relationships between quantitative variables were examined using Pearson's correlation for normally distributed data and Spearman's correlation for non-normally distributed data. A p value of less than 0.05 was considered statistically significant. Statistical analyses were conducted using IBM SPSS Statistics version 26.0.

Results

A total of 112 patients were included in this study. Among them, 40 (35.7%) were female and 72 (64.3%) were male, with a mean age of 11.6 years (range: 6-18 years). The average follow-up period was 10.1±2.3 months (range: 6-14 months). Of the total participants, 65 patients (58%) were diagnosed with PE, 42 (37.5%) with PC, and 5 (4.5%) had mixed-type deformities.

Echocardiographic evaluation was performed for all patients. Cardiac anomalies were detected in 11 patients (9.8%), including atrial septal defect (n=4), mitral valve prolapse (n=5), and mild pulmonary stenosis (n=2); none were severe enough to contraindicate non-invasive treatment, as determined by the pediatric cardiologist.

When the presenting complaints were evaluated, the most common reasons for consultation were cosmetic and psychosocial concerns (74,1%), followed by exertional dyspnea (18.8%) and recurrent respiratory infections (14.3%) (Table 1).

In patients with PE, the mean age was 11.7±2.8 years (range: 6-17 years). The gender distribution included 45 males (69.2%) and 20 females (30.8%). The average deformity depth was 2.5±0.7 cm (range: 1.6-3.8 cm). No significant gender differences were detected in the measured parameters. Symmetric deformity was observed in 48 patients (73.8%). The mean daily vacuum bell usage time was 2.7±1.0 hours, and the average treatment duration was 7.8±3.9 months. "Good treatment adherence" was defined as a daily vacuum bell use of ≥2 hours. Among patients with good treatment adherence, the deformity depth significantly decreased to 1.4±0.6 cm ($p<0.01$) (Table 2).

In PC patients, the mean age was 12.9±3.5 years (range: 7-18 years). Gender distribution was 27 males (64.3%) and 15 females (35.7%). The average deformity height (projection) was 1.9±0.5 cm (range: 1.2-2.7 cm). No significant gender differences were detected in the measured parameters. Symmetric deformity was present in 30 patients (71.4%). The mean daily custom-designed compressive bracing usage was 18±1.2 hours, and the average treatment duration was 8.5±4.6 months (Table 2). Good treatment adherence for PC was defined as brace usage ≥16 hours/day. Patients with good compliance demonstrated a significant reduction in deformity height (baseline: 1.9±0.5 cm; final: 1.3±0.4 cm; $p=0.032$). Clinical improvement was assessed subjectively by physicians and patients/parents based on criteria including cosmetic appearance and reduction in deformity height. The overall improvement rate (percentage of patients showing ≥50% reduction) was 72%.

In the group with mixed-type deformities (n=5), a combination of both vacuum therapy and bracing was used. Due to the small number of patients, no separate statistical analysis was performed, but varying degrees of clinical improvement were observed.

Overall, non-surgical treatment methods showed high rates of success in both cosmetic and functional aspects across all patient groups. None of the patients in our cohort required referral for surgical intervention during the follow-up period.

Discussion

This retrospective single-center study evaluated the effectiveness of non-surgical treatment methods, namely vacuum bell therapy for PE and custom-designed compressive bracing for PC, in a pediatric population. A total of 112 patients aged 5 to 18 years were included, with treatment adherence and early initiation shown to be associated with significant improvements in deformity depth and height. None of the patients required surgical intervention during the follow-up period. Our findings suggest that these conservative approaches are effective, safe, and represent viable alternatives to surgery when applied properly and consistently.

Table 1. **Presenting complaints in patients with PE and PC**

Presenting complaint	PE patients (n=65)	PC patients (n=42)	Total (n=112)
Cosmetic and psychosocial issues	51 (78.5%)	30 (71.4%)	83 (74.1%)
Exertional dyspnea	16 (24.6%)	5 (11.9%)	21 (18.8%)
Recurrent respiratory infections	12 (18.5%)	4 (9.5%)	16 (14.3%)

PE: Pectus excavatum, PC: Pectus carinatum

Table 2. **Demographic and clinical characteristics of the study groups**

Parameter	PE group (n=65)	PC group (n=42)
Mean age (years)	11.7±2.8 (range: 6-18 years)	12.9±3.5 (range: 7-18 years)
Gender distribution (M/F)	45 (69.2%)/20 (30.8%)	27 (64.3%)/15 (35.7%)
Symmetric deformity (%)	48 (73.8%)	30 (71.4%)
Mean deformity depth/height (cm)	2.5±0.7 (range: 1.6-3.8 cm)	1.9±0.5 (range: 1.2-2.7 cm)
Mean daily vacuum bell/custom-designed compressive bracing use (hours)	2.7±1.0	18±1.2
Mean treatment duration (months)	7.8±3.9	8.5±4.6
Deformity depth/height in patients with good compliance (cm)	1.4±0.6 ($p<0.01$)	From 1.9±0.5 to 1.3±0.4 ($p=0.032$)

PE: Pectus excavatum, PC: Pectus carinatum, M: Male, F: Female

Importantly, this study provides novel insight as one of the first to report real-world effectiveness of these non-surgical treatments for pectus deformities in our region. Despite being a single-center study, the relatively large sample size strengthens its contribution. The results reflect actual clinical practice and adherence in our local pediatric population, addressing a gap in the existing literature where such data remain limited.

Vacuum bell therapy has been in clinical use since the early 2000s. Initial pilot studies by Schier et al. (7) demonstrated its potential efficacy, leading to wider adoption as a primary or adjunctive treatment modality for PE. Later studies reported significantly better outcomes in patients under 11 years of age, with consistent vacuum bell use over extended periods-typically exceeding 12 to 24 months (8,9). The literature also highlights that initial deformity depth and early intervention are key factors influencing successful correction (10).

In line with these reports, our study population included relatively young patients, and good adherence to vacuum therapy correlated with a notable decrease in deformity depth. However, due to the retrospective design and sample size limitations, we did not perform statistical comparisons between age groups, daily usage duration, or anthropometric factors such as weight and height. This gap should be addressed in future prospective analyses.

For PC, prior studies have demonstrated high response rates with bracing therapy, with success rates exceeding 90% in some cohorts using custom-designed compression systems (2). Turkish data similarly support the efficacy of bracing, with over 94% of patients showing cosmetic improvement and most avoiding surgery (11). Our results were consistent with these findings.

Although no statistical analysis was conducted for the mixed-type group due to limited sample size, these patients will be followed longitudinally, and their outcomes may be evaluated in future prospective analyses as part of extended follow-up efforts.

Importantly, none of the patients in our cohort required referral for surgical intervention. This may reflect both the relatively mild-to-moderate severity of deformities in our population and high treatment compliance. Early initiation and regular follow-up may also have contributed to satisfactory outcomes.

Regarding treatment safety and adverse events, although a treatment-related complication rate of 22.8% was reported in our study, these were generally minor in nature-such as transient skin irritation or mild discomfort-and did not require discontinuation or medical intervention. This complication profile should not be interpreted as clinically significant. Similar findings have been reported in the literature. For example, Muff et al. (12) noted that 47% of patients undergoing vacuum bell therapy experienced minor side effects (e.g., skin erythema, hematoma), all of which were self-limited and resolved without sequelae.

Study Limitations

Limitations of our study include its retrospective design and the lack of imaging-based assessment. Although HI can be estimated from standard chest radiographs, we considered this approach to be less reliable compared to CT due to limitations in measurement consistency and accuracy. Therefore, we chose not to use it in our analysis. Nevertheless, effective follow-up was achieved through practical parameters such as physical examination findings and changes in deformity depth. This approach also helped avoid additional costs and unnecessary radiation exposure.

Although clinical observations in our cohort suggested that earlier initiation of non-surgical treatment might result in better outcomes, we did not perform subgroup comparisons based on age, gender, daily treatment duration, total treatment length, weight, or height. Furthermore, effect sizes and confidence intervals could not be calculated in this retrospective dataset. These constraints limit the statistical power of our findings. Future prospective studies with larger sample sizes are required to evaluate the statistical significance of these variables on treatment response.

Conclusion

This study highlights the effectiveness and safety of non-surgical treatment methods, such as vacuum bell therapy and custom-designed compressive bracing, as viable alternatives to surgery in pediatric patients with pectus deformities. Early treatment initiation and good patient adherence are crucial factors for achieving favorable outcomes. Moreover, regular follow-up and patient education play an essential role in maximizing treatment success.

However, due to the retrospective nature and sample size limitations of this study, future research should address factors such as age, treatment duration, and patient characteristics as predictive variables through structured prospective, long-term, and multi-center analyses to further validate and expand upon these findings.

Ethics

Ethics Committee Approval: The study was approved by the Ethics Committee of Ordu University with the decision number 2024/54 at the meeting held on June 7, 2024.

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: V.A., Concept: E.İ.A., Design: V.A., Data Collection or Processing: V.A., E.İ.A., T.K, Analysis or Interpretation: T.K., Literature Search: E.İ.A., T.K., Writing: E.İ.A., T.K.

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References

1. Kelly RE Jr. Pectus excavatum: historical background, clinical picture, preoperative evaluation and criteria for operation. Semin Pediatr Surg. 2008;17:181-193.
2. Martinez-Ferro M, Fraire C, Bernard S. Dynamic compression system for the correction of pectus carinatum. Semin Pediatr Surg. 2008;17:194-200.
3. Haje SA, Haje DP. Overcorrection during treatment of pectus deformities with DCC orthoses: experience in 17 cases. Int Orthop. 2006;30:262-267.
4. Mattioli G, Petralia P, Torre M, eds. Pediatric thoracic surgery. Cham: Springer; 2021.
5. Kwong JZ, Gulack BC. Non-surgical approaches to the management of chest wall deformities. Semin Pediatr Surg. 2024;33:151388.
6. Obermeyer RJ, Goretsky MJ. Chest wall deformities in pediatric surgery. Surg Clin North Am. 2012;92:669-684.
7. Schier F, Bahr M, Klobe E. The vacuum chest wall lifter: an innovative, non-surgical addition to the management of pectus excavatum. J Pediatr Surg. 2005;40:496-500.
8. Lei W, Shao M, Hu Y, et al. Vacuum bell therapy for pectus excavatum: a retrospective study. BMC Pediatr. 2024;24:173.
9. van Braak H, de Beer SA, Al Ghouch Y, et al. 15 years of vacuum bell therapy for pectus excavatum: long-term outcomes and influencing factors. J Pediatr Surg. 2025;60:161891.
10. Toselli L, Chinni E, Nazar-Peirano M, et al. Determinants of success associated with vacuum bell treatment of pectus excavatum. J Pediatr Surg. 2022;57:550-554.
11. Ermerak NO. Compressive external bracing in pectus carinatum: results of the first 100 patients. Marmara Med J. 2023;36:334-338.
12. Muff JL, Guglielmetti LC, Gros SJ, et al. Failed preoperative vacuum bell therapy does not affect outcomes following minimally invasive repair of pectus excavatum. Pediatr Surg Int. 2022;38:779.