Orthotic Intervention for the Treatment of Chest Deformities in Adolescents with Pectus Carinatum

Cerik Carter, MPO; Hanger Clinic; cecarter@hanger.com

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Clinical Question: What is the effectiveness of orthotic intervention in the non-operative management of pectus carinatum in adolescents?

Background: Pectus Carinatum (PC) is one of the two most common chest wall deformities. It is most commonly seen in males at a four to one ratio.[1] It can be congenital or come about later in life, often during adolescence.[1] During this time, PC can have many psychosocial effects such as acceptance of one's image or increase risk of harassment by peers.[2] Some adolescents even try to hide their deformity by wearing baggy clothes or excessively flexing their trunk, leading to poor posture.[2, 3] Surgical intervention is an option in managing PC but is often invasive and carries risks that non-operative management such as wearing an orthosis does not. The current literature in managing PC with orthotic intervention was appraised for this topic because of the psychosocial implications PC can have on individuals at an early stage of life.

Search Strategy: A database search using the Northwestern University Library resource was conducted through PubMed and CINAHL to find primary research articles addressing the clinical question.

Databases Searched: PubMed, CINAHL

Search Terms: ("pectus carinatum" AND bracing), ("pectus carinatum" AND brac*), ("pectus carinatum" AND orth*), ("pigeon chest" AND brac*)

Inclusion Criteria: Pectus Carinatum, articles published within the past 15 years, full-text access, published in English, data collected from a single treatment facility with participant's consent.

Exclusion Criteria: Pectus Excavatum, systematic reviews, data extrapolated from databases.

Synthesis of Results: Results of the primary research articles found orthotic intervention for PC to be successful by demonstrating improvements in visual satisfaction and ratios comparing the width and depth of the chest. One study experienced only a 40% success rate, but also experienced a 32% drop out rate. [4] This dropout rate likely limited the success rate of this study. Two other studies had success rates of 67%[5] and 84%[6], while a case series of 2 participants both had successful outcomes. Limitations across the board were a lack of consistency in the orthosis fitted to each participant and the method of measurement used.

Clinical Message: When looking at the efficacy of orthotic intervention to address the deformity seen in adolescents with pectus carinatum the literature supports the use of bracing to correct the deformity. It is also often the first line of treatment for individuals with pectus carinatum with surgical intervention as a backup if orthotic management is not successful. Though some individuals will require surgery following orthotic management, orthotic management has high success rates with early intervention without the inherent risks of surgery and comes with minimal down time. Success is largely achieved in younger adolescents with more malleable chests. A minimal wear time of at least 12-15 hours per day [5, 6] demonstrated good outcomes in 2 studies while some patients even wore their orthosis for 23 hours per day.[7] Setting the bar high may help reach a minimum effective wear time. One study suggested that 4.5 pounds per square inch of pressure was safe and effective at correcting the deformity.[5] Average time needed for correction ranges from 2-3 months, often followed by nocturnal wear for maintenance of about 6 months or until the chest wall has stiffened. Though a limitation of the literature was a lack of consistency in the types of orthoses used, successful outcomes were abundant, suggesting many types of orthoses used to treat PC may be effective.

References:

1. Fokin AA, Steuerwald NM, Ahrens WA, Allen KE. Anatomical, histologic, and genetic characteristics of congenital chest wall deformities. *Semin Thorac Cardiovasc Surg*. Spring 2009;21(1):44-57. doi:10.1053/j.semtcvs.2009.03.001
2. Steinmann C, Krille S, Mueller A, Weber P, Reingruber B, Martin A. Pectus excavatum and pectus carinatum patients suffer from lower quality of life and impaired body image: a control group comparison of psychological characteristics prior to surgical correction. *European Journal of Cardio-Thoracic Surgery*. 2011;40(5):1138-1145. doi:10.1016/j.ejcts.2011.02.019
3. Roberts J, Hayashi A, Anderson JO, Martin JM, Maxwell LL. Quality of life of patients who have undergone the Nuss procedure for pectus excavatum: Preliminary findings. *Journal of Pediatric Surgery*. 2003/05/01/ 2003;38(5):779-783. doi:https://doi.org/10.1016/jpsu.2003.50166
4. Kelly RE, Obermeyer RJ, Goretsky MJ, et al. Ten-year experience with staged management of pectus carinatum: Results and lessons learned. *Journal of pediatric surgery*. 2021;56(10):1835-1840. doi:10.1016/j.jpedsurg.2021.01.027
5. Al-Githmi Iskander S. Clinical experience with orthotic repair of pectus carinatum. *Annals of Saudi Medicine*. 2016/01/01 2016;36(1):70-72. doi:10.5144/0256-4947.2016.70
6. Shang Z, Hong C, Duan X, Li X, Si Y. Orthotic Bracing or Minimally Invasive Surgery? A Summary of 767 Pectus Carinatum Cases for 9 Years. *BioMed Research International*. 2021/02/19 2021;2021:6942329. doi:10.1155/2021/6942329
7. Nehra D, Ein SH, Tlumacki M, Masiakos PT. Pectus Carinatum: To Brace or Not to Brace—A Picture Is Worth 1770 Words. *Journal of prosthetics and orthotics*. 2009;21(3):167-170. doi:10.1097/JPO.0b013e3181b2cd81

Evidence Table

	Kelly, 2021[4]	*Shang, 2021*[6]	*Nehra, 2009*[7]	*Al-Githmi, 2016*[5]
Population	*695 total, 265 observed, 430 patients treated, 339 orthosis only, 65 surgical and 26 underwent surgery after trial with an orthosis; 88.1% males*	*596 boys and 171 girls between the ages of 26 months and 17 years of age*	*2 boys ages 14.5 years and 15 years of age*	*18 patients (17 male, 1 female), ages 10-23 years*
Study Design	*Retrospective comparative study*	*Retrospective Study*	*Case Report*	*Prospective Study*
Intervention	*Argentine or custom orthosis with prescribed wear at 8 hours per day minimum*	*Custom fabricated orthosis from 3-D scan. Requested wear of 12 hours every day*	*Custom fabricated braces, one constructed by patient's father (14.5 YO), and one by clinician (15 YO)*	*Custom fitted dynamic compression orthosis*
Comparison	Pre vs Post Treatment	Pre vs Post Treatment	Pre vs Post Treatment	Pre vs Post Treatment
Methodology	*Follow ups every month for 3 months, then 3-6 months to check compliance and observe flattening*	*Follow ups every 2 months with reexamination. Frontal and lateral chest x-rays with anteroposterior and transverse diameters measured.*	*Follow-ups as scheduled by clinicians. Visual inspection and observational note taking (No objective measurements mentioned)*	*Patients were measured and fitted with dynamic compression orthosis and instructed to wear the brace between 15 and 24 hours per day. Patients reevaluated at 4 weeks for compliance and every 3 months after until 12 months. Wear equal to or greater than 15 hours was compliant.*
Outcomes	*Pressure of Correction (POC) measured in pounds per square inch (PSI)*	*Diameter measurements of the patient's chest, and satisfaction of chest appearance*	*Before orthosis and after orthosis images were taken*	*Patient reported satisfaction scale (0=no correction, 4 =complete correction)*
Key Findings	*Bracing group experienced a 40% success rate and a 32% drop out rate. 21% were ongoing during the analysis and 7% failed treatment. Compliance and stiffness of chest highly impact success. Positive feedback through visible chest scans shown to patients*	*This study showed an 84% success rate. 108 of the 123 patients with failed orthotic management underwent surgery. Success was highest in younger pediatric patients with failure rates increasing with age. Average duration*	*Both patient's deformities significantly improved with the use of the orthosis. The deformity in case 1 was corrected after 3 months of wear while case 2 required 9 weeks. They found that correct application and compliance with wear are important factors to success.*	*Of the 18 participants, 67% of the participants scored themselves as a 3 or 4 indicating remarkable improvement and complete correction respectively. Noticeable results in 2 to 3 months. Mean corrective pressure of 4.5 PSI Suggests optimal treatment should begin*

	Kelly, 2021[4]	*Shang, 2021*[6]	*Nehra, 2009*[7]	*Al-Githmi, 2016*[5]
	may improve compliance.	*of treatment was typically 0.5-1 year.*	*Recommended wear was 23 hours per day until flattened, followed by 16 hours for 3 to 6 months to keep from wearing to school and activities. Nightly bracing following correction*	*in childhood or early adolescence. Patient compliance and regular wear of greater than 15 hours needed for successful outcome. Nightly bracing following correction.*
Study Limitations	*Two types of orthoses were used, some of the sample was still being treated when the study was wrapped up and one third of the patients dropped out, not knowing the outcome*	*Lack of consistency in orthosis type and design, skeletal maturity and stiffness of chest ranged widely with age*	*One orthosis was homemade and the other from a positive model of the patient, lack of consistency in methodology*	*Relatively small sample.*