Effect of Compression Bracing on Reducing the Severity of Pectus Carinatum

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**Clinical Question:** Is compression bracing an effective alternative to surgical repair in reducing the severity of pectus carinatum in well-motivated pediatric patients?

**Background:** Pectus carinatum (PC) is a deformity of the chest wall that results in a protrusion of the sternum and adjacent costal cartilage.<sup>7</sup> The incidence of pectus carinatum is 0.6% and occurs four times as often in males than females.<sup>7</sup> The ratio of pectus carinatum to pectus excavatum, a chest wall deformity that results in a concave appearance of the chest, has been reported to be between 3:1 and 13:1.<sup>1</sup> Surgical intervention has been the primary treatment method for pectus carinatum for the past 50 years.<sup>4</sup> However, recent studies have shown the effectiveness of compression bracing as a conservative treatment for pectus carinatum.

### **Search Strategy:**

Databases Searched: PubMed, <u>www.oandp.org</u>, Google Scholar
Search Terms: pectus carinatum, pectus, chest wall deformity, chest wall asymmetry, compression bracing, thoracic wall, chest wall
Inclusion Criteria: January 2007–present, English language, use of compression bracing
Exclusion Criteria: No use of compression bracing

**Synthesis of Results**: The results of five different studies regarding compression bracing for patients with pectus carinatum were reviewed. Two of the five studies used pressure sensors to determine the pressure in PSI needed to correct the pectus carinatum deformity. These studies showed that a lower pressure of compression (POC), indicating a more flexible chest wall, corresponded with shorter treatment duration and a greater likelihood of successful correction.<sup>2</sup> The mean daily wear time of the compression brace varied from 7.2 hours per day to 14.71 hours per day.<sup>5,6</sup> One study that used the Haller index (HI) found that the mean HI increased from  $2.13\pm0.18$  pre-treatment to  $2.98\pm0.24$  post-treatment.<sup>4</sup> Martinez-Ferro et al found that compression bracing achieved similar correction results to surgical repair with a lower incidence of overall complications and is the recommended treatment for pectus carinatum when indicated.<sup>6</sup> Overall, the five studies evaluated different outcome measures, but they all showed overall success with compression bracing based on subjective visual observation.

Clinical Message: While the bracing protocol, methods, and data gathered greatly varied, results from each of the five studies show that compression bracing is an effective method of treating pectus carinatum. Within the field of orthotics, few studies look at the effectiveness of pectus carinatum bracing. There is no standard agreed upon protocol for bracing and the current measure of effectiveness is subjective visual observation to see if the chest wall has flattened. In order to truly evaluate the effectiveness of pectus carinatum bracing, a quantitative, reliable, and reproducible outcome measure must be validated. The Argentine brace (dynamic compression system) uses a force sensor to measure the force in PSI required to flatten the sternum.<sup>6</sup> Additional studies are needed to validate this outcome measure, but this method shows potential to be a quantitative, reliable, and reproducible outcome measure.<sup>2,6</sup> The HI is a ratio of the measure of the transverse diameter of the chest divided by the sagittal measure of the distance from the sternum to the vertebral body.<sup>8</sup> According to literature published regarding pectus excavatum, an HI of 2 indicates a "normal chest" while an HI of less than 2 indicates pectus carinatum and an HI greater than 2 indicates pectus excavatum.<sup>8</sup> The results from Jung et al indicate values within the pectus excavatum range, but the increase in HI indicates a decrease in sternal protrusion.<sup>4</sup> Currently, this index is almost exclusively used to analyze patients with pectus excavatum and may be an effective outcome measure for pectus carinatum as well, but it requires a chest CT, which may not be indicated for every patient. The effectiveness of pectus carinatum bracing cannot be determined by quantitative means at this time, but subjective analysis by patients and physicians shows that compression bracing is effective in reducing the severity of pectus carinatum.

#### Effect of Compression Bracing on Reducing the Severity of Pectus Carinatum

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# **Evidence** Table

	<b>Cohee</b> , 2013 <sup>2</sup>	Jung, 2012 <sup>4</sup>	Loff, 2015 <sup>5</sup>	Martinez-Ferro, 2008 <sup>6</sup>	Nehra, 2009 <sup>7</sup>
Population	137 patients with PC, ages 10–28, median age 14	18 patients with PC, ages 3.4–19, 17 males, 1 female	69 patients with PC, ages 4–17, 94% male	208 patients with PC with mean age of 12.5 years (3– 18)	3 males with PC, ages 14.5 (severe PC), 15.5 (mild PC), and 15 (severe PC), all patients asymptomatic
Study Design	Retrospective study	Retrospective study	Retrospective study	Retrospective study	Case study
Intervention	Compression bracing with dynamic compression system for min. 8–12 hrs/day until sternal flattening Retainer wear for 12–18 months Home exercise program	Compression bracing for 20 hrs/day for 6 months	Compression bracing for 24 hrs/day	Compression bracing with dynamic compression system Patients instructed to wear brace overnight and as much as possible daily	<ol> <li>(1) Compression brace 23 hrs/day for 3 months, nocturnal wear for 2 years</li> <li>(2) Compression brace 23 hrs/day for 2 months, nocturnal wear for 3 months</li> <li>(3) Compression brace 21 hrs/day for 9 weeks, nocturnal wear until skeletal maturity</li> </ol>
Comparison	Abramson repair or open repair	None	None	Modified Ravitch procedure	None
Methodology	Visual assessment Pressure of Correction (POC) sensor	Visual assessment Chest CT scan Satisfaction survey	Visual assessment using pictures Patient survey of correction	Visual assessment Measurement of pressure with sensor Double-blinded subjective scale	Visual assessment
Outcomes	Subjective visual assessment POC	Haller index Satisfaction survey	Subjective visual assessment Angle between pectus	Subjective visual assessment Pressure of initial correction and of treatment	Subjective visual assessment

	<b>Cohee</b> , 2013 <sup>2</sup>	Jung, 2012 <sup>4</sup>	Loff, 2015 <sup>5</sup>	Martinez-Ferro, 2008 <sup>6</sup>	Nehra, 2009 <sup>7</sup>
			carinatum and vertical from lateral view	10-point correction survey	
Key Findings	Mean wear time with sternal flattening was 16 hrs/day; 14 hrs/day for those who failed treatment 30% saw flattening after 6 months 4% saw recurrence after end of treatment 11% failed treatment Median initial POC 4.7 PSI for patients with flattening and 5.5 PSI for patients without correction (significant difference) Lower POC corresponded with shorter treatment	Mean satisfaction score $3.73\pm0.39$ out of 4 among compliant patients Mean pre- treatment HI was $2.13\pm0.18$ Mean post- treatment HI was $2.98\pm0.24$	Mean wear time 14.71 hrs/day Mean correction of PC angle was 5.4° (0°-21°) Correlation between wear time and patient opinion of PC correction Best result with mean wear time 18 hrs/day	Mean wear time 7.2 hrs/day for 7 months (3–30) 88.4% achieved excellent, very good, or good results compared to 89% with surgery Overall complications from bracing less than surgery (12.5% vs. 22%) 15% recurrence Mean pressure of initial correction was 3.7 (0.4–9.5) PSI Pressure of correction <2.5 PSI prevents skin ulceration	All 3 patients presented had significant reduction of pectus carinatum deformity
Study Limitations	Brace follow up conducted by physical therapist instead of orthotist	No control group Small sample size	No control group Only analyzed data from patients aged 13–16	Bracing protocol modified during study	Only presented successful cases No control group Very small sample size