



Bracing in pediatric patients with pectus carinatum is effective and improves quality of life

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Abstract

Purpose: The purpose of this study was to examine the effectiveness and patient satisfaction with bracing for pectus carinatum (PC).

Materials and Methods: Twenty-five PC patients were treated between August 2007 and October 2011. Most patients were male (21/25,84%) with a mean age of 14.4 ± 2.0 yrs. A lightweight, patient controlled, external brace (Braceworks, Calgary, AB) was used. Monthly follow-up with anterior–posterior (AP) width measurements occurred until bracing was completed. Three quality of life (QOL) questionnaires were used: SF-36, SSQ, and PEEQ.

Results: Group 1 involved twenty patients who successfully completed bracing (12/25,56%) or who are still bracing (8/25,32%). Group 2 comprised five patients who failed bracing (2/25,8%) or who were noncompliant (3/25,12%). One patient who failed bracing underwent successful Ravitch repair. AP width decreased more in those with successful bracing (2.31 vs 0.64 cm, $p=0.05$). Questionnaires were completed by 19/25 (76%) patients. Pre-bracing, the SF-36, and PEEQ revealed that few patients were symptomatic, although most still avoided activities which showed their chest. The SSQ revealed that the majority of patients were very satisfied with their post-bracing appearance, experienced minimal discomfort while bracing, and would use the brace again. Self-esteem increased significantly after bracing (7.5 vs 8.7, $p=0.01$).

Conclusions: Bracing in PC patients is very effective in a compliant patient with close follow-up. Surgical repair remains feasible if bracing fails.

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Pectus carinatum (PC) is characterized by protrusion of the sternum resulting from overgrowth of the costal cartilages [1–3]. The overall prevalence of PC is 0.6%, with 80% of cases being male [1,3]. PC is usually considered a cosmetic deformity [4]. Despite its lack of physiological symptoms, PC tends to affect patients psychologically [3,5], instilling embarrassment due to the appearance of their chest

[6]. PC can be present since birth or may develop and worsen during adolescence [7]. PC patients become aware of their chest wall deformity and its lack of attractiveness. Most PC patients will avoid any activity in which their chest will be seen, e.g. swimming. Correction of their PC is speculated to improve self-esteem and confidence [8]. Until recently, the only methods of correction for PC patients involved aggressive surgical intervention in the form of an open or modified Ravitch or minimally invasive procedures [5,9,10]. Intraoperative risks, such as excessive bleeding and

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pneumothorax, as well as postoperative complications, such as scarring, pain, and asphyxiating thoracic dystrophy can be significant [2,11].

Given that the chest wall is still compliant during adolescence, as demonstrated by Nuss bar correction of pectus excavatum [12], remodeling is possible using external pressure by a brace [3,9]. Non-surgical treatment of PC avoids operative intervention and its possible complications, is scarless, and is less costly than surgery [6,9]. Although compressive bracing has been found to yield highly satisfactory results in adolescents [1,5–7,10], the ideal treatment of PC remains controversial. In addition, no study has examined the psychological effects of bracing. The aim of this study was to examine the effectiveness and patient satisfaction of bracing to correct PC in pediatric patients.

1. Materials and methods

After obtaining IRB approval, the charts of all PC patients treated with a lightweight, patient-controlled, external brace (Braceworks, Calgary, AB) (Fig. 1) at the Children's Hospital in London, Ontario, between August 2007 and October 2011 were reviewed. With specific measurements taken by the surgeon and a tracing of the chest deformity performed, a custom-designed brace was created. The brace was adjusted accordingly to ensure a perfect fit. Patients wore a snug fitting undershirt under the brace at all times to prevent skin breakdown. Patients were then seen monthly for anterior–posterior (AP) width measurements and to ensure that there were no difficulties with the brace. We followed the Calgary protocol for the duration of the study [1]. Briefly, patients wear the brace for 23 h per day (correction phase) until the chest is flat (approx. 4–8 months). During the maintenance phase (approx. 4–8 months), patients brace for 8 h per day (usually at nighttime). Upon completion of



Fig. 1 Patient wearing the lightweight, external brace (picture courtesy of Braceworks, Calgary, AB). Black arrow points to one of the adjustable portions of the brace.

Table 1 Patient characteristics.

	N	Mean $\pm$ SD
Duration of PC prior to diagnosis (yrs)	22	2.25 (0.5–13) ^a
Age at the start of bracing (yrs)	25	14.4 $\pm$ 2.0
Length of correction phase (mos)	22	4.5 $\pm$ 2.7
Length of maintenance phase (mos)	14	3.9 $\pm$ 3.0
Total change in AP diameter (cm)	22	2.13 $\pm$ 1.19

SD=standard deviation, AP=anterior–posterior.

^a Median value (range).

bracing, patients continue to be followed to ensure that their chest remains flat.

Variables analyzed included patient demographics and the total change in AP diameter. Three quality of life (QOL) questionnaires were used to assess patient satisfaction with bracing. Due to lack of PC QOL questionnaires, we slightly modified 3 existing ones: (a) SF-36 (health related QOL questionnaire) and (b) PEEQ (Pectus Excavatum Evaluation Questionnaire) and SSQ (Single Step Questionnaire) (both disease specific QOL questionnaires for pectus excavatum patients) (Tables 1, 2 and 3). These questionnaires have been previously validated [8,13,14]. All questionnaires were mailed to each patient with an explanatory letter as well as a letter of consent. For those patients who had not returned the questionnaire after 1 month, we contacted them by telephone. A second mailing was done if they were interested. A few patients preferred to complete the questionnaires by telephone.

All data were analyzed using SPSS software (version 11, Chicago, IL) and included the Student's t-test, paired t-test or non-parametric Mann–Whitney test where appropriate. Statistical significance was considered to be p less than 0.05.

2. Results

Of the twenty-five patients with PC in this study, 21 (84%) were male. The median duration of PC prior to diagnosis was 2.25 years (range 0.5–13 yrs) (Table 1). The mean age at the start of bracing was 14.4 $\pm$ 2.0 years (range 11.3–17.4 yrs). By the end of the study, twenty-two patients (88%) had completed the correction phase of bracing. The average length of the correction phase was 4.5 $\pm$ 2.7 months (range 1–13 months). Eight patients (32%) were in the maintenance phase. Of the 14 patients who completed bracing, the average maintenance phase length was 3.9 $\pm$ 3.0 months (range 1–11 months). The median range of follow-up in clinic was 0.25 yrs (range 0.83). However, almost all patients were contacted recently by telephone. No recurrences were reported by the 14 patients who have completed bracing.

Three patients (12%) never returned to clinic after their 1st or 2nd followup visit and were deemed noncompliant. One of these patients braced for only 3 months yet his AP

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