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Factors affecting patient compliance with compressive brace therapy for pectus carinatum

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Abstract

OBJECTIVES: The aim of this study was to identify factors affecting patient compliance with brace therapy for pectus carinatum.

METHODS: Eighty-six pectus carinatum patients who started brace therapy from August 2008 to November 2011 were included in this study. Patients were divided into two groups: patients who wore the brace for ≥6 months (compliance group) or patients who wore the brace for <6 months (non-compliance group). Factors affecting patient compliance were assessed at the last day of follow-up with a multiple-choice questionnaire. The questionnaire comprised seven items: pain at compression site, skin problems on compression area, confidence in brace treatment, shame, discomfort, initial result of bracing treatment and total number of factors affecting patient compliance.

RESULTS: Eighty-six patients completed the survey, including seven (8.1%) female patients and 79 (91.9%) male patients, with a mean age of 12.0 years at the time of treatment (range, 3–20 years). The initial result of the compression period (P <0.001) and total number of factors affecting patient compliance (P <0.05) were significant predictors of patient compliance.

CONCLUSIONS: An initial successful result of the compression period may increase patient compliance during treatment for pectus carinatum. Additional efforts to decrease pain, skin problems, shame and discomfort, and to give confidence may be beneficial in increasing compliance with bracing treatment.

Keywords: Pectus carinatum • Brace therapy • Compliance

INTRODUCTION

Pectus carinatum (PC), or also termed pigeon chest, is the second most common paediatric chest wall deformity [1]. The definitive aetiology of PC is not clear, and PC patients with physical symptoms are rare [1]. Consequently, most patients choosing to treat PC report cosmetic concerns as the primary reason for correction [2]. Operative repair of PC has been the predominant treatment for over 50 years since its first introduction by Ravitch [3]. However, since Haje and Raymundo reported their experience with nonoperative bracing for the correction of PC in 1992 [4], bracing has been considered the primary option for selected patients by most paediatric surgeons [5]. While current studies show that bracing is effective and patient satisfaction can be improved after treatment, bracing can fail due to patient non-compliance [6, 7]. Therefore, patient compliance is the most important factor for bracing therapy success. The causes of patient non-compliance have not been reported previously, and the aim of the present study was to analyse the factors affecting patient compliance.

MATERIALS AND METHODS

Eighty-six consecutive PC patients who started brace therapy in Ajou University Hospital between August 2008 and November 2011 were included in this study. All patients were treated with a compressive brace and answered a questionnaire about the factors affecting their compliance. Patients with genetic disorders such as Marfan syndrome, Poland syndrome, patients with complex carinatum or excavatum malformations, and patients with chondromanubrial type of PC were excluded from this study. All the patients except two patients (5- and 14-year old girls) who had isolated second costal cartilage protrusion had a chondrogladiolar type of PC. We reviewed the medical charts of all patients treated for PC to obtain data pertaining to demographics, pertinent medical history, complications and clinical outcomes. This study was approved by our institutional review board.

Each patient received an initial examination consisting of a visual inspection of the chest wall shape and a manual compressive test during their first hospital visit. The manual compressive test evaluated the flexibility of costal cartilage when the protrusion area of the chest was compressed with the palm of one hand and

the thoracic spine was supported by the other hand. If partial or complete reduction of the protrusion was observed, the deformity was considered flexible. In this study, all patients except one showed complete reduction and only one showed partial reduction according to the manual compressive test.

Through collaboration with a certified orthotist, we designed a fitted chest compression brace for each patient (Fig. 1). Two light aluminium bars were positioned on the anterior and the posterior chest. An adjustable buckle and strap ratchet kit was attached on each end of each bar, and two straps were connected to the buckles for fastening. The pad was made of a plastic plate covered by a soft cushion to decrease friction on the skin. The anterior pad was used for compression of the PC. After fitting the compression brace, two ink marks were made on the two straps to identify the point of fastening. When the patients removed the brace for bathing or to change clothes, it could be refastened using the ink marks. The patients were instructed to wear the brace over a t-shirt for skin protection for 20 h per day during the compression period (2–4 weeks) and 10 h per day during the maintenance period (6 months). This 6-month protocol was made based on the preliminary tests and reference with previous studies and a good result has been reported with this protocol [6, 8]. In addition to wearing the compressive brace, patients were instructed to perform deep breathing, push-ups and sit-ups as frequently as possible without removing the brace.

The first follow-up visit was scheduled after 2–3 weeks to assess the patient's initial compliance, fit of the orthosis and the initial result of the compression period. Subsequent visits were completed every 3 months until the treatment was deemed successful. We performed follow-up chest posterior-anterior and chest lateral at each visit as possible.

Because the result of the brace therapy is proportional to the duration of wearing the brace, the patients were divided into two groups according to the duration of brace wearing: patients who wore the brace for ≥6 months (compliance group) and patients who wore it for <6 months (non-compliance group).

Patient characteristics are summarized in Table 1. Eighty-six patients completed the survey, including seven (8.1%) female patients and 79 (91.9%) male patients, with a mean age of 12.0 years at the time of treatment (range, 3–20 years). Symmetry of PC deformities was validated in 77 patients; 30 (39.0%) were symmetric deformities. The overall mean duration of wearing a bracing device was 4.6 months. There were no patients who aborted the brace therapy due to complication and there were no events where the surgeon decided to terminate the brace therapy.

Factors affecting patient compliance were assessed at 12 months after the start of brace therapy on follow-up with a questionnaire consisting of multiple-choice questions. The questionnaire comprised seven items: pain at compression site, skin problems on the compression area, confidence in brace treatment, shame, discomfort, initial result of the compression period and total number of factors affecting patient compliance. Pain was defined as pure pain on the compression area and discomfort was defined as a stuffy sense or any other discomfort with the bracing device. As mentioned previously, the initial result of the compression period was estimated by visual inspection at 2–4 weeks after starting the bracing treatment with the brace removed; the initial result was considered successful when the patient's PC deformity seemed to be nearly corrected and unsuccessful when the patient's PC deformity showed little or no correction. The total number of factors was defined as the sum of factors that affected the compliance of each patient.

Patient satisfaction was measured using a scoring sheet at 12 months after the initiation of treatment. A score of 1, 2, 3 or 4 was assigned when a patient felt that <25, 25–50, 50–75% or >75% improvement was achieved, respectively. The satisfaction score was assessed subjectively by a parent if the patient was a child, and patients older than 15 years assessed the score themselves.

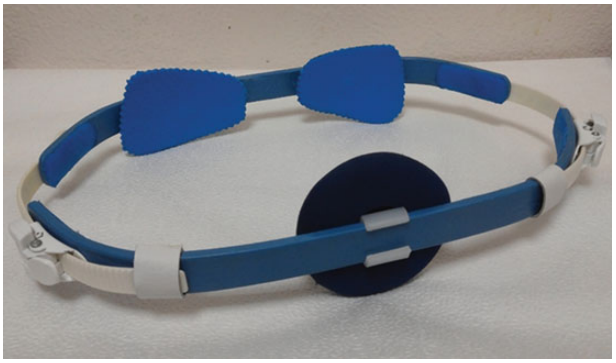

Figure 1: Photograph of lightweight, self-adjustable compressive brace designed for the treatment of pectus carinatum.

Table 1: Patient characteristics

Characteristics	Number (%)
Gender	
Male	79 (91.9)
Female	7 (8.1)
Family history of pectus carinatum	
No	57 (66.3)
Yes	24 (27.9)
Missing	5 (5.8)
Pectus carinatum symmetry	
Symmetric pectus carinatum	30 (34.9)
Asymmetric pectus carinatum	47 (54.6)
Missing	9 (10.5)
Compliance	
Compliance group	42 (48.8)
Non-compliance group	44 (51.2)

All statistical analyses were performed with SPSS for Windows, version 20.0 (Statistical Package for Social Sciences, SPSS, Inc., Chicago, IL, USA). Categorical variables were summarized in terms of frequency and percentage, while continuous variables were summarized as the mean and range. Comparisons of categorical variables were performed using the χ^2 test and Fisher's exact test, and comparisons of continuous variables were performed using Student's *t*-test. Factors with a *P*-value of 0.1 or less were included in a binary logistic regression test to identify the major independent factors affecting patient compliance. For all statistical analyses, $P < 0.05$ was considered statistically significant.

RESULTS

The compliance group included 42 (48.8%) patients, and the non-compliance group included 44 (51.2%) patients. Two patients who had isolated second costal cartilage protrusion were included in the compliance group. Statistical testing revealed no significant differences in age, gender, symmetry and family history between the two groups (Table 2). Mean reported values for pain on the compression area, skin problems on the compression area,

Table 2: Demographics of compliance and non-compliance groups of pectus carinatum patients

	Compliance group (*n*)	Non-compliance group (*n*)	*P*-value
Mean age (years)	11.6	12.7	0.387
Gender			
Male	37	42	0.180
Female	5	2	
Symmetry			
Yes	13	17	0.364
No	26	21	
Family history			
Yes	14	25	0.234
No	10	32	

Table 3: Self-reported factors affecting pectus carinatum patient compliance with bracing treatment

	Compliance group (*n*)	Non-compliance group (*n*)	*P*-value
Pain			
No	19	13	0.132
Yes	23	31	
Skin problems			
No	37	36	0.417
Yes	5	8	
Confidence			
No	41	40	0.361
Yes	1	4	
Shame			
No	37	33	0.119
Yes	5	11	
Discomfort			
No	14	9	0.177
Yes	28	35	
Initial result of compression			
Successful	38	7	<0.001
Unsuccessful	4	37	
Mean total number of factors	1.48	2.02	0.001

confidence in brace treatment, shame and discomfort were not significantly different between the two groups. However, there were statistically significant differences in the initial result of the compression period (P <0.001) and the total number of factors affecting patient compliance (P <0.05) between the two groups (Table 3). Additionally, binary logistic regression testing indicated that the initial result of the compression period (P <0.001) and the total number of factors affecting patient compliance (P <0.05) were significant predictors of patient compliance. The compliance group showed a higher satisfaction score (P <0.001) than the non-compliance group (Table 4).

Table 4: Satisfaction scores of compliance and non-compliance groups of pectus carinatum patients

	Satisfaction score (*n*)			
	1	2	3	4
*Compliance group	2	1	14	25
Non-compliance group	23	4	11	6
Total	25	5	25	31

*The compliance group showed a higher satisfaction score (P <0.001) than the non-compliance group.

DISCUSSION

Bracing treatment is considered the preferred first-line treatment in PC patients, although there are limited data regarding the long-term results [5, 9]. However, bracing may not be effective if patients do not wear the brace for a sufficient period of time each day. Therefore, patient compliance with regular brace wear is very important for the success of this method.

Many problems associated with brace orthotics, such chest discomfort, pain and shame have been speculated to be important factors affecting patient compliance [6, 10–12]. However, Colozza *et al.* reported that all patients (regardless of success or failure with bracing treatment) experienced minimal discomfort due to the brace; non-compliant patients reported that minimal change in PC was the main reason for discontinuing the brace treatment [9]. Furthermore, Lee *et al.* reported that positive results in the initial 3–4 weeks after bracing seemed to increase patient compliance [13].

Our data demonstrated that the initial result of the compression period and the total number of factors affecting patient compliance were the main predictors of patient compliance. Therefore, if patients do not achieve a successful result in the initial period after brace treatment, more reminders such as additional follow-up and phone calls to these patients may be needed to increase compliance. Additionally, physicians are advised to reassure PC patients that bracing treatment is effective.

As mentioned previously, pain, skin problems, confidence, shame and discomfort did not significantly affect patient compliance. However, the sum of these factors significantly influenced patient compliance. Therefore, efforts to improve these factors may also be important. For example, a gradual increase of bracing force may be helpful to decrease the pain and skin problems, and the development of more convenient bracing orthotics may decrease the shame and discomfort associated with using a brace.

Lee *et al.* reported that younger patients at an earlier stage of puberty were less likely to maintain compliance because bracing affected patient activity in and out of school [13]. However, the age difference was not statistically significant between the compliance and non-compliance groups in our study. This different result may be due to the age difference between our study group (mean, 12.0 years) and that of Lee *et al.* (mean, 14.4 years). In our study, relatively young patients were enrolled, and these patients may care less about the negative perceptions of other individuals due to their bracing treatment.

Few previous studies have explored patient satisfaction with bracing treatment for PC. However, patient satisfaction is a more important element to assess the success of the brace therapy, because most patients with PC do not have specific physical symptoms and just want to correct their appearance. Colozza *et al.* reported that patients who successfully completed bracing noted a significant improvement in the appearance of their chest and that their social activities were no longer affected. In our

study, success of brace treatment was defined in cases of >50% of improvement and the success rate was 65.1%. Moreover, a higher satisfaction score was recorded in the compliance group. Therefore, we assumed that the better results of bracing treatment in compliant patients result in improved satisfaction with bracing treatment for PC.

The official follow-up visit ended at 12 months after the start of brace therapy. At first, we informed the patient whether the procedure was a success or failure at 6 months and then we recommended the surgical option for unsuccessful patients. But most of patients realized that the unsuccessful result was due to the short duration of application of the brace by them. Only two patients proceeded with a surgical treatment (minimally invasive repair of PC with pectus bar) among half of the patients who were unsuccessful. This means that unsuccessful patients have partial satisfaction with improvement with brace therapy and they do not want surgical correction for this deformity.

However, there were some limitations to this study. Firstly, our 6-month protocol for bracing treatment was shorter than previous studies, although there are no objective guidelines regarding how long brace orthotics have to be applied and when assessment of success or failure can be done. The reason is that we can recommend surgical option for no delay of the optimal surgical period in case of an unsuccessful result after 6 months of brace treatment. Therefore, we need a long-term result for our protocol. Secondly, the degree of the severity of PC and assessment of symmetry was not fully evaluated objectively due to the lack of national medical insurance coverage and parental objection to radiation exposure. The effect of compressive bracing was evaluated using only the satisfaction scores of patients for the same reasons. Thirdly, 44 of 86 patients (47.7%) had suboptimal results after the initial compression period. We think that the reason for this was poor compliance rather than failure to select the proper candidate, because the mean age of patients was 12 years old and most of the patients showed complete reduction according to the manual compressive test.

In conclusion, an initial successful result of the correction period may increase patient compliance with bracing treatment for PC, and efforts to decrease pain, skin problems, shame and discomfort as well as to improve confidence in bracing treatment may be warranted.

Conflict of interest: none declared.

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