

Effect of the compressive brace in pectus carinatum

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Abstract

Background: Patients with pectus carinatum complain of cosmetic problems because they stand out in spite of wearing clothes. Surgical treatment of pectus carinatum is resection of the deformed cartilage but a wide operative scar, postoperative pain and complications related with the operation can occur. Therefore we have performed compressive brace therapy as a non-operative treatment of pectus carinatum, and observed the effects and the efficiency of this treatment. **Materials and methods:** From January 2001 to December 2007, 119 patients with pectus carinatum were treated with a compressive brace that they wore for 24 h each day. Their degree of satisfaction was measured after 6 months wearing. This was evaluated with a score of 1–4. A score of 1 was assigned when the status was worse, 2 when it was same, 3 when partially improved, and 4 when a remarkable improvement was observed. Satisfaction was assessed subjectively by a parent if the patient was a child, and patients older than middle school age assessed the score themselves. **Results:** The mean overall satisfaction score was 3.95 ± 0.4 . Recurrence of pectus carinatum after removal of the compressive brace occurred in 6 (5.0%) of the total 119 patients. Four of these six patients stopped wearing the compressive brace against our advice. These six patients were re-corrected by re-wearing the compressive brace within 3 months after they originally removed it. Complications were discomfort at initial wearing of the brace, which occurred in all patients, skin rash due to compression for 84 patients (70.6%) and skin discoloration due to excessive compression for 18 patients (15.1%). The skin rash and discoloration disappeared within a few months after removal of the brace. **Conclusion:** This study demonstrated that non-surgical treatment using a compressive brace in patients with pectus carinatum was effective, especially in children and teenagers. Non-surgical treatment using a compressive brace in patients with pectus carinatum would be helpful for those who dislike surgery because of their fear about general anesthesia and operative complications. But, long-term follow-up is necessary to evaluate the effectiveness of this compressive brace and the recurrence of the condition after its removal.

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Keywords: Pectus carinatum; Chest deformity; Compressive brace

1. Introduction

Pectus carinatum describes a protrusion of the chest over the sternum. Patients with pectus carinatum generally live without special symptoms or signs but complain of cosmetic problems because they stand out in spite of wearing clothes. Surgical treatment of pectus carinatum is resection of the deformed cartilage but a wide operative scar, postoperative pain and complications related with the operation can occur. Therefore, we have performed compressive brace therapy as a non-operative treatment of pectus carinatum, and observed the effects and the efficiency of this treatment.

2. Patients and methods

2.1. Object of study

From January 2001 to December 2007, 206 patients with pectus carinatum were treated with a compressive brace at Soonchunhyang University Cheonan Hospital in South Korea. Forty-two patients wearing the compressive brace less than 12 h in a day, 13 patients wearing the compressive brace every 2 or 3 days, and 4 patients wearing the compressive brace because of partial bulging of the anterior chest after surgery for pectus excavatum were excluded from this study. One hundred and forty-seven patients initially wore a compressive brace for 24 h each day, but 22 of these patients discontinued use of the brace part way through this study. This left 125 patients for this study but 6 were lost to follow-up. Consequently, we report the progress of 119 compliant patients.

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Fig. 1. Manual compressive test used to evaluate flexibility of the pectus carinatum. The anterior protrusion area was compressed with the palm of one hand while the thoracic spine was supported by the other hand.

2.2. Indications for treatment with a compressive brace

The initial exam was a manual compressive test when patients with pectus carinatum visited our hospital. 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, while the thoracic spine was supported by the other hand (Fig. 1). If partial or complete reduction of the protrusion was observed, the deformity was considered flexible. Flexibility of costal cartilage is good in children and teenagers, but decrease in adults 20 years or older. Seven patients with pectus carinatum over 20 years old wanted treatment with a compressive brace, and were included in this study. Chest CT was performed on patients included in this study. This showed the degree of bulging of the chest, and anomalies of the cardiothoracic area.

2.3. Manufacture and wearing of the compressive brace

The manufacture of compressive braces was done by a special factory. Two light aluminium bars, each including a pad were positioned on the anterior of the chest and the posterior of the thoracic spine. A buckle was attached on each end of each bar, and two straps were connected to the buckles for fastening. A strap over each shoulder prevented the bars from slipping and falling down. The pads were made of plastic plates covered by soft leather to decrease the effect of friction on the skin. The anterior pad was used for compression of pectus carinatum, and the posterior pad provided support for the



Fig. 2. Picture of front (A) and back (B) of the compressive brace. The brace consists of anterior and posterior pads, straps under the both axilla for fastening, and shoulder straps.

Table 1
Scores of degree of satisfaction

1: When the status was worse
2: When it was same
3: When partially improved
4: When a remarkable improvement was noticed

spine (Fig. 2). After fitting for the wearing of compressive brace, two ink marks were made on the two straps to identify the point of fastening. Even if patients removed the brace for a bath or to change clothes, it could be refastened using this ink mark. In addition to wearing the compressive brace, patients were instructed to perform deep breathing as frequently as possible without removing the brace. Weightlifting and abduction–adduction of the pectoralis three times each day was recommended for exercise.

2.4. Follow-up

Out-patient follow-up was done at an interval of 2 or 3 months after wearing of the compressive brace. We tried follow-up chest CT for radiological comparison. However the Korean national medical insurance did not cover chest CT of the pectus carinatum during the follow-up. Given that situation, most patients have been reluctant to take a chest CT, so no special exam has been performed. Fastening of the axillary straps and the effectiveness of the brace were evaluated. If they were loose, the axillary straps were fastened to the correct tension.

2.5. Satisfaction degree

The degree of satisfaction was checked after 6 months from initiation of treatment. This was measured by a score of 1–4 (Table 1). A score of 1 was assigned when the status was worse, 2 when it was same, 3 when partially improved, and 4 when a remarkable improvement was observed. The satisfaction score was assessed subjectively by a parent if the patient was a child, and patients older than middle school age assessed the score themselves.

3. Results

3.1. Ages and distribution of sex

The mean age of patients was 12.91 ± 4.3 (range, 5–28 years). There are 107 male and 12 female patients.

3.2. Assessment of degree of satisfaction

Every patient less than 19 years old scored 4. In 19–28 years, four patients out of 10 scored 3 and two patients

Table 2
Degree of satisfaction by age

Age	Degree of satisfaction
5–18 years ($n = 109$)	4.0
19–28 years ($n = 10$)	3.20 ± 0.8
Overall ($n = 119$, mean age: 12.91 ± 4.3)	3.95 ± 0.4



Fig. 3. Picture of pre-correction state (A) and post-correction state (B). The anterior protrusion area of the chest was depressed to near normal after wearing the brace.

scored 2. Average satisfaction score was 3.20 ± 0.8 in 19–28 years. Overall average satisfaction score was 3.95 ± 0.4 (Table 2). Photography showed an improvement over the pre-treatment state (Fig. 3).

3.3. Recurrence

The brace should be removed if the protrusion of chest was corrected. Further compression was not necessary. We did not remove the brace abruptly, instead, the durations of brace wearing time was reduced slowly during a period of 2–3 months. Recurrence of the condition sometimes occurred in spite of slow removal of the brace.

Table 3
Profile of recurred patients

No.	Age (year)	Wearing duration (months)	Weaning duration (months)	Recurring period after weaning (months)
1	8	6	0	2
2	12	6	0	2
3	16	6	0	2
4	17	6	0	3
5	3	6	2	4
6	15	6	3	5

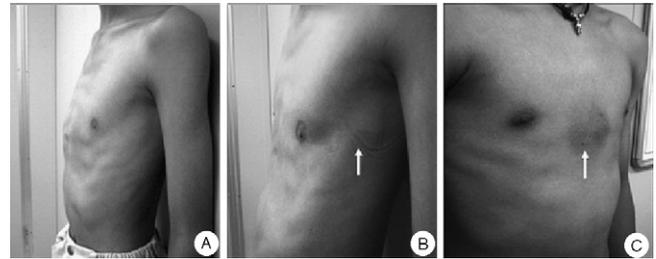


Fig. 4. Picture showing pre-correction state (A) post-correction state (B). Temporary skin rash (B, white arrow) due to wearing of brace occurred. Temporary skin rash (B, white arrow) was a red color originally. Temporary skin discoloration (C, white arrow) due to excessive tightness of compressive brace. Temporary skin discoloration (C, white arrow) is a dark red color originally.

Table 4
Complications ($n = 119$)

Skin rashes	84 patients (70.6%)
Skin discolorations	18 patients (15.1%)

Six of 119 patients (5.0%) who wore the brace for 24 h each day experienced recurrence 2–5 months after removal of the brace, and were asked to initiate wearing it again. Four of these six patients stopped wearing the brace against our advice (Table 3). The six patients who experienced recurrence were re-corrected by re-wearing the compressive brace within 3 months after they originally removed it.

3.4. Complications

No special complications occurred in these 119 patients except initial discomfort when they began wearing the compressive brace. Skin rashes occurred on anterior compressed chest skin in 84 patients (70.6%) (Fig. 4). The cause of these skin rashes was compression of the chest wall. Skin discolorations occurred in 18 patients (15.1%) for whom excessive compression was used for quick correction (Table 4). Skin rashes and discolorations were a temporary phenomena and normalized after removal of the brace (Fig. 4).

3.5. Weaning of braces

Weaning off the braces was tried after 6 months of wearing in 119 patients. We did not wean the brace abruptly. We told patients to gradually reduce the wearing time for 2–3 months and then remove the braces.

4. Discussion

Pectus carinatum represents a spectrum of protrusion abnormalities of the anterior chest wall. Hippocrates described the carinatum deformity as a 'sharply pointed chest' and reported that patients became 'affected with difficulty breathing' [1]. Since his description, various findings have been reported; the most prominent are cosmetic and psychological. Some patients develop rigidity of the chest wall with decreased lung compliance, progressive emphysema, and increased frequency of respiratory tract infections [1]. The overall prevalence of pectus carinatum is estimated at 0.06% [2]. Approximately one third of patients have a positive family history of pectus deformities [3] also, 14% of the pectus carinatum patients with scoliosis required therapeutic intervention [4]. Males are affected four times more frequently than females [5]. Although pectus carinatum has been described at birth, it is most frequently identified in mid childhood. The deformity often worsens during the adolescent growth spurt. The deformity may be classified as either chicken breast (chondrogladiolar) or Pouter pigeon breast (chondromanubrial), depending on the site of greatest prominence, and lateral deformities are also possible [6]. Many methods of surgical treatment have been reported, but the main procedures are resection of all deformed cartilage and osteotomy of the sternum. This operation had satisfactory results and the recurrence rate after operation is nearly 2% [5]. However, many patients with pectus carinatum and their parents will not consent to this operation because of fears of surgery and anesthesia, cosmetic problems with the operative wound, pain after the operation and complications related to the operation. Therefore, we developed the compressive brace as a non-surgical treatment. Non-surgical treatment of pectus carinatum was applied firstly by plaster casts [7]. After that, many non-surgical treatments with a brace were introduced and good results were reported [8–12]. Long-term results of the use of a compressive brace for pectus carinatum have not been previously reported. We tried follow-up chest CT for radiological comparison. However the Korean national medical insurance did not cover chest CT of the pectus carinatum during the follow-up. Given that situation, most patients have been reluctant to take chest CT, so no special exam has been performed.

In this study, results were good in children and juveniles but the brace effects decreased in adults above 19 years old. The recurrence rate was 5.0% for this 6-year study, but patients who experienced recurrence were corrected by re-wearing of the brace. The most important thing for compressive treatment of pectus carinatum is the timing of removal of the brace. The brace should not be removed abruptly. The wearing time per day should be reduced gradually for 2–3 months prior to removal of the brace. The wearing time per day should be increased if the patient feels re-protrusion of the chest subsequently to reducing the wearing time. Patients feel some discomfort when they wear the brace initially, but they gradually adapt to it. Some patients even feel empty after removal of the brace. In this study, 22 patients among the 147 patients who wore the compressive brace for 24 h each day stopped the treatment

part way through the study. Some patients stopped the treatment completely, and some wore the compressive brace for 8–12 h per day or half of a day in every other day. They controlled the wearing time themselves. The main reason for stopping treatment was shame and discomfort due to wearing the brace. Juveniles stopped more than children. Wearing of the compressive brace usually started in autumn. Winter passed and the brace was removed in spring because the treatment was difficult in the hot summer. We started brace therapy from autumn to spring in 87 patients but 32 patients did it from winter to summer. These 32 patients complained of discomfort from wearing the brace in summer. Based on this study, we do not propose that all patients with pectus carinatum should be treated using a compressive brace. But non-surgical treatment using a compressive brace for patients with pectus carinatum may help them avoid surgery and have flexible costal cartilage, especially with juveniles and child patients.

4.1. Study limitation

This study has some limitations. We used only the satisfaction scores, which are subjective, and no objective findings have been assessed. We tried follow-up chest CT for radiological comparison. However the Korean national medical insurance did not cover chest CT of the pectus carinatum during the follow-up. Given that situation, most patients have been reluctant to take chest CT, so no special exam has been performed. Therefore we used only a degree of satisfaction as a tool of comparison.

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