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Effect of the Boston thoracic brace on the frontal and sagittal curves of the spine

The purpose of the present study was to compare the sagittal and lateral curves in progressive idiopathic scoliosis treated conservatively with the Boston thoracic brace. The importance of the delordosation was confirmed. The correlation was, however, seen only between correction of the lumbar lordosis and correction of the lumbar scoliosis. The correction of the proximal thoracic scoliosis with the brace was equally good, without a similar correlation between correction of the proximal scoliosis and correction of the sagittal curves being observed.
A coupling between the correction of the two scolioses may therefore be suspected. Further, the correcting forces of the Boston thoracic brace seemed to be approximately the same, independent of the range of the scoliosis, at least between 10° and 40°.

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The purpose of the present paper was to study the characteristics of the horizontal and sagittal curves in patients with progressing idiopathic scoliosis, treated with a flexion brace (Boston thoracic brace).

Material and methods

The material comprised 30 consecutive patients (28 girls and 2 boys), all with right convex thoracic and left convex lumbar idiopathic scoliosis (Table 1). All patients had verified progressive curves (an increase of 5° or more). Six patients had double major scoliosis (difference ≤ 5° between the two curves). The mean age of the patients when treatment was started was 14 (12–16) years. The level of the apex of the thoracic curves was T7–T10 and of the lumbar curves L1–L3.

All the patients had been referred to the Spinal Unit at the Department of Orthopaedic Surgery, Malmö General Hospital during 1982, for the construction and fitting of a Boston thoracic brace (without upright). The technique for producing these braces was exactly the same in all cases and was that recommended by the Boston group (Watts et al. 1977). All braces were manufactured by two experienced orthotists.

Methods

The range of the scoliosis was determined radiographically according to Cobb (1948) in a standing, relaxed PA-position with and without the brace.

The sagittal curves of the spine in relaxed standing and maximally erect positions, with and without the brace, were evaluated by a so-called spinal pantograph. This is a mechanical, non-invasive device for registering, among other things, the sagittal curves of the spine reduced by a known scale (Willner 1981, 1983, Willner & Johnsson 1983). A significant correlation was seen between the radiograph and the pantograph observations, concerning the range of the kyphosis and the lordosis. A high reproducibility when using this technique was also observed. Because of the free posterior space of the Boston thoracic brace, changes of the sagittal curves in the brace could also be estimated.

Results

The mean correction of the thoracic as well as of the lumbar scoliosis was about 50 per cent (Table 1). The mean correction of the kyphosis was about 26 per cent and of the lordosis 40 per cent (Table 2).

Table 1. Horizontal and sagittal curves of the spine in 30 cases with idiopathic scoliosis with and without Boston brace in standing position

	Without the brace M±SD (range) degrees	With the brace M±SD (range) degrees
Thoracic scoliosis	29± 8 (10–43)	15±7 (2–33)
Lumbar scoliosis	27± 7 (14–39)	15±7 (0–30)
Thoracic kyphosis	28±12 (12–53)	20±9 (6–42)
Lumbar lordosis	30± 9 (17–49)	18±7 (5–38)

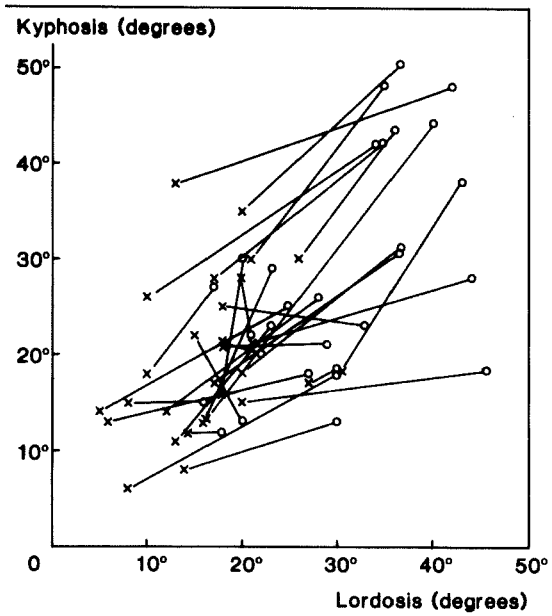

Figure 1. The relationship between the kyphosis and the lordosis with (×) and without (o) the Boston thoracic brace.

In a maximally erect standing position without the brace, the mean kyphosis was 20° ± 10°, which was almost identical with the range of the mean kyphosis in the brace when the child was standing in a relaxed position. In a maximally erect position with the brace, the mean correction of the kyphosis was 14° ± 9°.

When the child was standing in a maximally erect position without the brace, the mean lordosis was 29° ± 9° (range 16–49°). No correction was thus seen compared with the range of the lordosis in a relaxed standing position. Even in the brace, no active further correction of the lordosis was observed (Table 2). The changes of the kyphosis and the lordosis in the separate cases are demonstrated in Figure 1.

There was no correlation between the range of the thoracic scoliosis and the kyphosis, nor between the lumbar scoliosis and the lordosis.

Furthermore, no correlations were observed between the correction of the thoracic and the lumbar scoliosis and the range of the kyphosis and lordosis, respectively, without braces.

The relationship between the correction of the horizontal and the correction of the sagittal curves was also studied. No significant correlation could be seen between the correction of the thoracic scoliosis and either the kyphosis or the lordosis. On the other hand, a positive correlation ($0.01 > p > 0.001$) was noted between the correction of the lumbar scoliosis and the correction of the lumbar lordosis.

The range of the correction of the thoracic scoliosis was, however, correlated ($0.01 > p > 0.001$) to the range of the correction of the lumbar scoliosis. This may indicate that there is a kind of coupling between the proximal and distal curves.

Finally, the range of the percentage correction of the thoracic scoliosis was negatively

Table 2. Corrections of the horizontal and sagittal curves (per cent) of the spine in 30 cases with idiopathic scoliosis in the standing relaxed position with and without a brace and in a maximally erect standing position

Correction between	M±SD (range) (per cent)
Thoracic scoliosis without – with the brace on	47±21 (12– 93)
Lumbar scoliosis without – with the brace on	47±20 13–100)
Thoracic kyphosis without – with the brace on	26±28 (–70– 70)
Lumbar lordosis without – with the brace on	40±21 (5– 80)
Kyphosis relaxed – erect position without the brace on	30±19 (0– 74)
Lordosis relaxed – erect position without the brace on	2±19 (–40– 41)
Kyphosis relaxed – erect position with the brace on	34±32 (0–100)
Lordosis relaxed – erect position with the brace on	–1±28 (–66– 60)

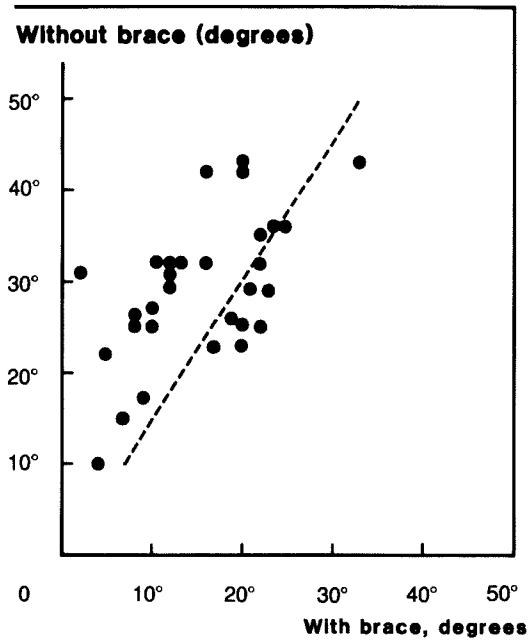

Figure 2. Comparison between the thoracic scoliosis with and without the brace.

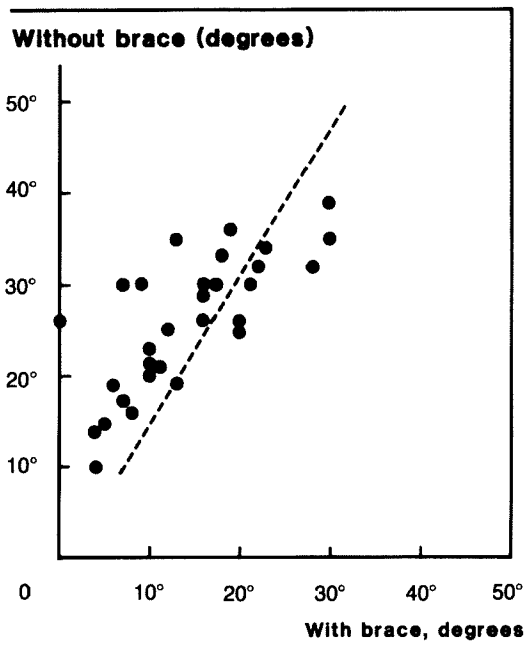

Figure 3. Comparison between the lumbar scoliosis with and without the brace.

correlated ($0.01 > p > 0.001$) to the range of the curve without the brace. No corresponding, similar findings could be seen between the correction of the lumbar scoliosis and the range of the lumbar curve, even though a certain tendency to this can be suspected.

The range of the primary correction of the thoracic and lumbar scolioses with the brace (Figures 2 and 3, respectively) seemed to be approximately the same, independent of the range (10–43°) of the scoliosis.

Discussion

In recent decades new types of scoliosis braces have been developed. These have been shown to prevent mild and moderate scolioses from progressing. The primary correction of the scoliosis has been about 50 per cent. The final result, however, 5–10 years after the cessation of brace-wearing has not been as successful. Only a slight, permanent correction has been reported (Keiser & Schufflebarger 1976, Mellencamp et al. 1977).

The forces acting as a correction on the scoliosis when using these types of braces are distraction and lateral forces. Further, it has been assumed that the efficiency of these forces is increased by the flexioning of the lumbar lordosis. The distraction forces, however, are of little importance in cases suitable for conservative treatment. The most effective force is thus the lateral push on the trunk, aiming to correct the lateral deviation as well as the rotation. The derotational effect of the Boston brace was demonstrated by Aaro (1980); the initial decrease of the rotational component as seen with CT-scan was 38 per cent.

The importance of the delordosation of the lumbar lordosis was emphasized by Watts et al. (1977), Lind (1980) and Udén & Willner (1983). A more detailed understanding of these correcting factors, however, has not, as yet, been established. The purpose of the present paper was, therefore, to study the relationship between the initial correction of the lateral and sagittal curves by a prefabricated Boston brace. The brace seemed to have approximately the same correction forces acting on

both the thoracic and the lumbar scoliosis. This has also been assumed in other studies (Udén et al. 1982). The possibility of decreasing the lumbar lordosis with the brace is also obvious.

The sagittal curves of the spine were also studied in a maximally erect position and compared with a relaxed position with and without the brace. The range of the active correction of the kyphosis without the brace was the same as that in the brace, in the relaxed position. The lumbar lordosis in an erect standing position without the brace, however, did not change significantly compared with the relaxed position, but in the brace a correction of 40 per cent was observed. This shows an obvious passive delordosating property of the brace. With the child wearing the brace and standing in a maximally erect position, the kyphosis could further be actively corrected by 30%. The lordosis, however, was unchanged in the brace when the spine was maximally erect.

When studying the relationship between the range of the correction of the lumbar scoliosis and the range of the correction of the lumbar lordosis, a positive significant correlation was seen. On the other hand, no significant correlation could be observed either between the correction of the thoracic scoliosis and the kyphosis, or between the thoracic scoliosis and the lumbar lordosis. This supports former opinions about the importance of the delordosating properties of the brace, particularly concerning the correction of the lumbar scoliosis. This observation, however, cannot be applied directly to the correction of the proximal curve.

An interesting observation here was the positive correlation between the correction of the proximal and distal curves. How this can be explained is obscure. A positive anatomical coupling between the proximal and the distal curves may be suspected, the nature of which does not seem to have anything to do with the correction of the sagittal curves.

The correction of the thoracic as well as the lumbar scoliosis was independent of the initial curvatures (Figures 2 and 3); that is, the percentage correction decreased with increasing curvature. On the other hand, no correlation was seen between the degree of the scoliosis and the degree of the sagittal curves. These findings are supported by Pelker & Gage (1982), who also did not observe any relationship between the range of lumbar scoliosis and lordosis. A negative correlation may be suspected between the kyphosis and thoracic scoliosis, as the flattening of the kyphosis is often seen in progressive, severe scoliosis – all cases in this study were proved to be progressing.

Acknowledgement

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