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Cosmetic Outcome after Conservative Treatment of Idiopathic Scoliosis with a Dynamic Derotation Brace

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Abstract. Improved cosmesis is a major concern for the adolescents with Idiopathic Scoliosis (IS). We hypothesized that if we correct the rotation simultaneously to the lateral curvature of the spine with a dynamic brace we may decrease the asymmetry of the back and ultimately improve the cosmetic appearance of the scoliotic child.

Thirty six scoliotic children (32 girls and 4 boys) with a mean age of 13.9 (range 12-17) years, a mean Cobb angle of 28,2^{o} (range 19-38^{o}) and a mean ATI 7,8^{o} (range 4^{o}-17^{o}) were studied. The examined children were divided in 3 subgroups according to the curve type. All children wore the Dynamic Derotation Brace (DDB), which is a modified Boston brace with antirotatory blades, for 23 hours per day, for a minimum duration of 2 years. The ATI was assessed using the Pruijs scoliometer at baseline and at the end of treatment.

ATI was improved statistically significant in the thoracolumbar ($p<0.01$) and lumbar region ($p<0.013$) of double curves and in the thoracolumbar ($p<0.018$) and lumbar region ($p<0.027$) of thoracolumbar curves. ATI improvement in the thoracic region was not statistically significant either in double curves ($p<0.088$) or in thoracolumbar curves ($p<0.248$). For right thoracic curves, ATI improvement was not statistically significant for all the examined regions.

The above findings indicate that in double and thoracolumbar curves, a deforming torsional force is present, blocked by the antirotatory action of the blades of the DDB, and seems to be more active in the "lower" spine.

In conclusion, DDB improves the cosmetic appearance of the back of IS children with all but right thoracic curves.

Keywords. Idiopathic scoliosis, conservative treatment, surface deformity, Angle of Trunk Inclination, Dynamic Derotation Brace, cosmetic outcome in Idiopathic Scoliosis

Introduction

Improved cosmesis is a major concern for the adolescents with Idiopathic Scoliosis (IS) [1]. Traditionally, conservative treatment with a brace aims at prevention of curve progression beyond surgical limits, and its effectiveness is evaluated by radiographic measurements, namely the Cobb angle and vertebral rotation. The patient satisfaction, the cosmetic appearance of the back and the overall quality of life have recently been introduced as important factors in evaluation of the conservative treatment effectiveness.

The typical cosmetic appearance of the back in children with IS, is back asymmetry and is usually the first noticed sign. A simple method to quantify back asymmetry is by measuring the Angle of Trunk Inclination (ATI) with the use of scoliometer. Improvement of ATI should be one of the primary goals of conservative treatment in IS.

Back asymmetry is mainly the clinical expression of rib cage deformity and spinal column 3-D deformity, including vertebral rotation. Any attempt to improve the cosmetic result should focus on correction of both the scoliotic curve and the rotation. If the corrective forces are applied to a relatively immature skeleton, it could theoretically improve the rib cage asymmetry and result in a better cosmetic appearance.

It is known that the Dynamic Derotating Brace (DDB) acts by the application of corrective forces to the scoliotic curve, but additionally derotates the spine with its metallic antirotatory blades which are attached on the posterior surface of it [2]. We hypothesized that if we correct the rotation simultaneously to the lateral curvature of the spine with a dynamic brace we may decrease the asymmetry of the back and ultimately improve the cosmetic appearance of the scoliotic child.

Material-Method

Thirty-six scoliotic children treated conservatively with a DDB are included in the study. Most of them were detected through the school-screening program. All the patients wore the brace for 23 hours per day for a minimum duration of 2 years.

According to the curve type they were divided into three groups: In the *first group* there were 20 children, 17 girls and 3 boys, with a double curve (right thoracic with a compensatory lumbar), a mean age 12.3 years old (range 10-17) and a mean follow up time of 28 months (range 24-34). The mean thoracic Cobb angle was 23.2^o (range 10^o-35^o) and a mean lumbar 21.2^o (8^o-30^o) respectively. Mean ATI in the thoracic, thoracolumbar and lumbar region was 6.1^o (range 0^o-15^o), 6.6^o (0^o-10^o) and 3.2^o (0^o-10^o) respectively (see Table 1**).** In the *second group* there were 6 children, all girls with a right thoracic curve and a mean age of 13.8 years (range 12-15) and a mean follow up was 25 months (range 24-28). Mean thoracic Cobb angle was 25^o (range 22^o-31^o). Mean ATI in thoracic, thoracolumbar and lumbar region was 4.5^o (range 0^o-8^o), 6^o (2-10^o) and 5.3^o (3^o-8^o) respectively (see Table 1**).** In the *third group* there were 10 children, 9 girls and 1 boy, with a thoracolumbar curve and a mean age of 13.5 years (range 12-17) and a mean follow up time of 29 months (range 24-36). The mean Cobb angle was 24^o (range 20^o-38^o). Mean ATI in thoracic, thoracolumbar and lumbar region was 5.4^o (range 0^o-15^o), 3.6^o (6^o-17^o) and 4.2^o (0^o-14^o) respectively (see Table 1**).**

Table 1. The three groups of the 36 studied scoliotic children with the Cobb angle and ATI measurements at baseline. Th: Thoracic region, Tl: Thoracolumbar region, Lu: Lumbar region.

	No of pts	Curve type	Mean age (years)	Mean Cobb angle (degrees)	Mean ATI (degrees)			Mean Follow Up (months)
					Th	Tl	Lu	
Group I	20	Double	12.3 (10-17)	Th 23.2 (10-35) Lu 21.2 (8-30)	6.1 0-15	6.6 0-10	3.2 0-10	28 (24-34)
Group II	6	Right Thoracic	13.8 (12-15)	25 (22-31)	4.5 0-8	6.0 2-10	5.3 3-8	25 (24-28)
Group III	10	Thoraco lumbar	13.5 (12-17)	24 (20-38)	5.4 0-15	3.6 6-17	4.2 0-14	29 (24-36)

DDB is a modified underarm TLSO - Boston brace with antirotatory blades, which act as springs, maintaining constant correcting forces at the pressure areas of the brace and produce at the same time movements in opposite directions of the two side halves of the brace. The derotating metallic blades are attached to the rear side of the brace corresponding to the most protruding part of the thorax (hump) or the trunk of the patient. They become active when their free ends are located underneath the opposite side of the brace and the brace is tightened. The forces applied by the derotating blades are added to the side forces exerted by the brace aiming in both the correction of the spinal and the correction of the rotational deformities of the chest and the trunk. [2].

The effect of DDB on the cosmetic appearance of the back was assessed by measuring ATI at thoracic, thoracolumbar and lumbar region of each curve using the Pruijs scoliometer at baseline and at the end of treatment.

Correlations were determined by the Pearson correlation coefficient, with $p<0.05$ considered significant. The SPSS v.12 was used for the statistical analysis.

Results

In *group I,* at the end of treatment, the mean ATI in the thoracic, thoracolumbar and lumbar region in standing position was 4.4^{o} (range 0^{o}-10^{o}), 3.1^{o} (0^{o}-10^{o}) and 0.9^{o} (0^{o}-5^{o}) respectively. ATI improvement was statistically significant in thoracolumbar ($P<0.01$) and in lumbar region ($p<0.013$) but not in thoracic region ($p<0.088$) (see Table 2).

In *group II,* at the end of treatment, the mean ATI in the thoracic, thoracolumbar and lumbar region in standing position was 3.8^{o} (range 0^{o}-7^{o}), 4^{o} (0^{o}-8^{o}) and 3.5^{o} (2^{o}-5^{o}). ATI improvement in group II was not statistically significant for all the examined regions (see Table 2).

In *group III,* at the end of treatment, the mean ATI in the thoracic, thoracolumbar and lumbar region in standing position was 4.4^{o} (range 0^{o}-10^{o}), 2.3^{o} (0^{o}-15^{o}) and 3.4^{o} (0^{o}-13^{o}) respectively. In standing position ATI improved statistically significant in thoracolumbar ($p<0.018$) and in lumbar region ($p<0.027$) but not in thoracic region ($p<0.248$) (see Table 2).

Table 2. Statistical significance of ATI improvement. SS: Statistically significant, NSS: Non statistically significant.

	Thoracic ATI	Thoracolumbar ATI	Lumbar ATI
Group I	p<0,088 (NSS)	p<0,01 (SS)	p<0,013 (SS)
Group II	p<0,180 (NSS)	p<0,066(NSS)	p<0,066 (NSS)
Group III	p<0,248 (NSS)	p<0,018(SS)	p<0,027 (SS)

A graph of ATI improvement at the three examined regions of the back in the three groups of scoliotic children is shown in Figure 1.

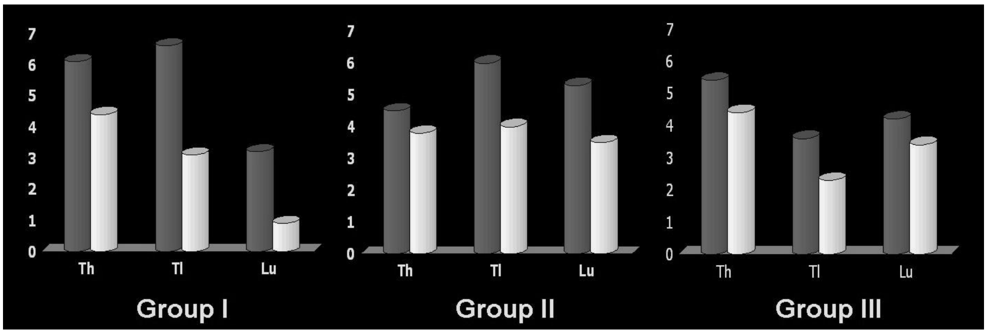

Figure 1. A graph showing ATI improvement at the three examined regions of the back in the three groups of scoliotic curves. *Grey bar*: Mean ATI at baseline, *White bar*: ATI at the end of treatment. ATI is measured in degrees. Th: Thoracic region, Tl: Thoracolumbar region, Lu: Lumbar region.

Discussion

The efficacy of the various orthotic devices is controversial [3, 4, 5]. There are studies in the literature where the results documented that bracing altered the natural history of IS by preventing curve progression [3], or by reducing the number of patients requiring surgery [4]. Other authors believe that there is lack of data to support brace management of IS and they are questioning the necessity of school screening due to the uncertainty of the efficacy of treatment with a brace, stating that early detection may not necessarily prevent curve progression and the need for surgical intervention [5].

The issue of corrective forces and how these forces should be applied on a scoliotic curve in order to achieve maximum correction is not new [6]. Different types of braces are using different principles of correction [6]. A very common mistake is to correct the lateral curvature of the spine without correcting the rotation of the trunk. Furthermore, a proper designed brace could be ineffective when applied by orthotists or physicians who are not following the above principles. Therefore, in order to evaluate the effectiveness of brace treatment we need to establish some quality criteria and not include all braces as a whole and subjectively comment about their efficacy [6].

The forces applied by the derotation blades of the DDB are added to the lateral forces applied by the brace resulting in both the correction of the spinal curvature and the correction of the rotation of the trunk. DDB is an "aetiologic" brace [2] because it overcomes the deforming forces of spiral composite muscle trunk rotator, which has been integrated by the Nottingham theory for IS pathogenesis [7, 8]. The essential feature of this theory is a failure of control of cyclical rotations in the spine during gait [9]. For mild and moderate curves, which after a successful conservative treatment remain below 45^{o} is unlikely to affect the health status [10], but they always have a cosmetic impact on the scoliotic patient. Therefore the effect of a brace on cosmesis is crucial in evaluating the results of conservative treatment.

A previous study revealed that DDB has a positive effect on correction for the majority of curves treated conservatively [2] and can change the natural history of IS, by improving both the Cobb angle and the vertebral rotation. The present study shows that although DDB as a dynamic brace is very effective, it is able to improve significantly the ATI of the thoracolumbar and lumbar region, while the effectiveness on the thoracic ATI is relatively poor.

One possible explanation is that the antirotatory blades of the DDB are very likely to create an antirotatory force and block the deforming torsional action of the asymmetrically acting spiral composite muscle trunk rotator in the thoracolumbar and lumbar spine. The deforming rotatory forces which are generated by the asymmetric action of a component of the above described spiral composite trunk rotator muscle are probably involved in the pathogenesis of IS in the "lower" spine, while for the "upper" spine there must be some other factors, such as the rib cage which through a different unknown mechanism may initiate the deformity [11]. The counter-action of the antirotatory blades of the DDB to the above rotation-inducing system on the thoracolumbar and lumbar spine makes some aetiological implications that neuromuscular factors are involved in the aetiology of IS.

The findings of the present study revealed the limitations of DDB in improving cosmesis at the thoracic region although it is very effective in improving the Cobb angle. An effective brace should ideally correct both the Cobb angle and the surface deformity of the back, in order to achieve both radiological correction and patient satisfaction.

Conclusion

DDB improves the cosmetic appearance of the back, more effectively in scoliotic patients with double and thoracolumbar curves, particularly in the thoracolumbar and lumbar region. The thoracic region of the above curves and the surface deformity in patients with thoracic curves seems to remain unaffected.

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