Research Article   **OMICS International**

Effect of SpineCor Dynamic Brace Treatment on the Result of Surgical Correction of Adolescent Idiopathic Scoliosis

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Abstract

Introduction: Unsuccessful preventive treatment of adolescent idiopathic scoliosis, including brace treatment, often results in the decision to perform surgery. The aim of the presented study was to determine whether using a SpineCor dynamic brace has an effect on further surgical correction of the main curve, as well as whether the length of time a patient stops using the brace before the surgical procedure and the length of preventive treatment have any effect on the final outcome of the surgery.

Methods: The study encompassed patients who underwent surgery to correct lateral curve deformation of the spine. The study group (Group A) comprised patients who underwent preventive treatment with a SpineCor dynamic brace. The rest of the patients, who did not undergo preventive treatment, constituted the control group (Group B). The magnitude of curve deformation was assessed based on the Cobb angle in X-ray images taken in a standing position from the anteroposterior view. Measurements were taken before the surgical procedure (measurement 1), directly after the surgery (measurement 2), and 12 months after the surgery (measurement 3). Subsequently, the correction of the curve was calculated at both one week and 12 months after the surgery.

Results: Satisfactory correction was obtained in Groups A and B, as shown from both measurements: one week (71 ± 13 in Group A and 66 ± 15 in Group B) and 12 months after the surgical procedure (68 ± 20 in Group A and 65 ± 17 in Group B). Differences between the groups were not statistically significant. On average, brace treatment in the experimental group lasted 25 ± 8 months. No statistically significant correlation between the length of brace treatment and the correction of the curve was observed. On average, the non-brace period before the surgical procedure was 7.5 ± 4.9 months and it did not have a significant effect on the course and final outcome of surgical treatment.

Conclusions: As far as adolescent idiopathic scoliosis is concerned, preventive treatment with a SpineCor brace before the surgery did not have a significant effect on the course and final result of the surgical correction of the curve, either immediately or within one year after the surgical procedure.

Keywords: Idiopathic scoliosis; Scoliosis correction; SpineCor dynamic brace

Introduction

Treatment of idiopathic scoliosis as a three-dimensional spine deformation depends on many factors, the most important of which are the patient's age (skeletal maturity), and the magnitude and progression of curve deformation. The standards involve: observation (mild curves), orthopedic supplies in the form of corrective braces (SRS standards: curve size between 25° and 40°, Risser sign between 0 and 2, and 10 years of age or older) [1,2], and surgical treatment for severe curve, greater than 40° if preventive treatment is unsuccessful [3,4]. An important procedure in preventive treatment, and the only one that is documented, is bracing, the aim of which is to reduce the risk of curve progression in order to avoid surgical procedure [3,5,6]. The SpineCor dynamic brace is a special type of orthopedic supply for a particular type of scoliosis, constituting a 20 hour therapy that supports the patient using a new corrective motion strategy and achieving integration on the skeletal-muscular-nervous level [6,7].

Unsuccessful brace treatment results in the decision to perform surgery. The main objective of surgical treatment for idiopathic scoliosis is the safe and maximal correction of all deformations and the restoration of proper balance on all three planes. According Sun et al. write that satisfactory correction of the curve can be achieved in patients who undergo surgery due to idiopathic scoliosis and have been earlier treated preventively with a brace. However, a history of brace treatment may have a negative effect on the final outcome of the surgery by reducing the flexibility of the curve, which results in poor correction [3]. There are no reports about the effect of using a SpineCor dynamic brace on the course of surgical treatment. The aim of this study was to assess whether using this type of preventive treatment would significantly influence the correction of the main curve achieved during surgery. The answer to the question of whether the time of brace weaning before the surgery and the duration of preventive treatment have any effect on the correction achieved after surgery also seemed important.

After obtaining the Bioethics Committee permission, the study was conducted among patients who underwent surgical correction of the lateral curve deformation of the spine in single orthopedic centers between 2013 and 2015. A group of patients who had previously been treated for idiopathic scoliosis with a SpineCor dynamic brace was selected from among all the patients who had the surgery (Group A). The remaining inclusion criteria for this group were as follows: over 10 years of age at the time of surgery, a Cobb angle value at the time of the surgery exceeding 45°, and brace treatment duration of no less than 18 months. The control group (Group B) comprised patients who had not been treated preventively before the surgical procedure. Otherwise, the inclusion criteria for Group B were the same as Group A except for the history of brace treatment. Surgical corrections of the lateral curve of the spine were conducted in both groups using the anterior approach (17.95% from Group A and 39.13% from Group B) and the posterior approach (82.05% from Group A and 60.87% from Group B). All surgeries were performed by the same team of specialists. The study assessed the magnitude of the curve based on the Cobb angle in X-ray images taken in a standing position from the anteroposterior view. Measurements were taken before the surgical procedure (measurement 1), directly after the surgery (measurement 2), and 12 months after the surgery (measurement 3). Subsequently, correction of the curve was calculated at both one week and 12 months after the surgical procedure was calculated using the following formula:

$$\frac{(\text{magnitude of curve before surgery} - \text{magnitude of curve after surgery})}{(\text{magnitude of curve before surgery})} \times 100\%$$

The data obtained in this manner were compared between the two groups. Statistical analysis was performed using Student's t-test and the Mann-Whitney U test. Student's t-test for independent variables was used to compare two groups of independent data when the normality of distribution of variables and the homogeneity of variance criteria were fulfilled. The Mann-Whitney U test was used to compare two groups of data collected according to the model of independent variables for measurements that were performed on an ordinal scale or for data that deviated strongly from the normal distribution on an interval scale. The hypotheses on the stochastic independence of variables were verified with a level of significance of $p=0.05$.

Results

The study group (Group A) comprised 40 patients (38 girls and 2 boys), with a mean age at the time of the surgery of 14.6 ± 1.7 years (ages 11-19) and the mean value of the Cobb angle before surgery was 72° ± 12° (46°-102°). The most prevalent curves were double primary curves and thoracic primary curves, which were observed in 52.5% and 35.0% of the patients from this group, respectively.

The control group (Group B) comprised 46 patients (44 girls and 2 boys), with a mean age at the time of the surgery of 15.2 ± 1.6 years (ages 11-19) and the mean magnitude of the Cobb angle before surgery was 68° ± 14° (46°-101°). In this group, the most prevalent curves were double primary curves (41% of patients) and thoracic primary curves (41% of patients). Both groups were similar in terms of age, sex, and the type and magnitude of the curve before the surgery (Tables 1 and 2).

	Group A	Group B	P value
Age at surgery (year)	14.6 ± 1.7	15.2 ± 1.6	0.116
Pre-op main curve magnitude (°)	72 ± 12	68 ± 14	0.171
Post-op main curve magnitude (°)	22 ± 11	23 ± 11	0.564
Curve correction (%)	71 ± 13	66 ± 15	0.142
1-year post-op main curve magnitude (°)	24 ± 14	24 ± 10	0.988
1-year post-op curve correction (%)	68 ± 20	65 ± 17	0.216
Values are shown in mean ± SD			

Table 1: Physical characteristics before and after surgery between Groups A and B.

Subgroups of curve pattern	before	after	1 year after
Main Th			
Braced (n=14)	68 ± 18	23 ± 9	26 ± 18
	(46-102)	(11-38)	(10-60)
Non-braced (n=19)	72 ± 13	26 ± 7	27 ± 8
	(49-88)	(15-40)	(15-45)
Main double Th and L			
Braced (n=21)	71 ± 11	20 ± 12	19 ± 11
	(49-87)	(1-54)	(1-47)
Non-braced (n=19)	65 ± 11	20 ± 12	21 ± 11
	(44-80)	(1-41)	(6-47)
Main Th-L and L			
Braced (n=5)	76 ± 14	26 ± 10	35 ± 14
	(63-95)	(17-42)	(23-57)
Non-braced (n=8)	67 ± 20	23 ± 16	20 ± 12
	(46-101)	(2-51)	(2-38)
Th thoracic, double Th and L, Th-L thoracolumbar, L lumbar			
Values are shown in mean ± SD			

Table 2: Comparisons of the curve magnitude between subgroups of curve location.

The mean duration of brace treatment was 25 ± 8 months (18-48). The study did not reveal any statistically significant correlation between the duration of the treatment and the correction of the curve. The mean non-brace period before the surgical procedure was 7.5 ± 4.9 months (6.1-24.0), and it had no effect on the course and final result of the surgical treatment.

The mean magnitude of the curve directly after the surgical procedure was 22° ± 11° (1°-50°) in Group A and 23° ± 11° (1°-51°) in Group B; 12 months after the procedure the mean magnitude of the curve was 24° ± 140 (0°-60°) in Group A and 24° ± 10° (2°-47°) in Group B. The study did not reveal any statistically significant difference

for either group in the mean value of the Cobb angle directly after the surgery and 12 months after the surgical procedure. The correction obtained in Groups A and B was satisfactory after the procedure as shown for both measurements (Table 1).

After taking the location of the primary curve in both groups into account, no statistically significant differences in correction at either one week or 12 months after the surgery were observed (Table 3). Considering the method for the conducted surgical procedure, no significant differences were revealed between the groups as to the magnitude of the curve or the correction. In Group A, scoliosis in the patients who underwent surgery using the posterior approach demonstrated greater correction 12 months after the procedure than it did in patients who underwent surgery using the anterior approach (72 ± 15% vs. 47 ± 27%, p=0.005). In Group B, the difference in the correction of scoliosis 12 months after the procedure between patients who underwent posterior approach surgery and those who underwent anterior approach surgery was very close to being statistically significant (69 ± 14% vs. 59 ± 19%, p=0.053).

Subgroups of curve pattern	Curve correction (%)		Curve correction (%) 1-year post-op	
Main Th				
Braced (n=14)	68 ± 10	P=0.208	63 ± 30	P=0.345
Non-braced (n=19)	62 ± 12		60 ± 17	
Double (Th and L)				
Braced (n=21)	73 ± 15	P=0.501	74 ± 13	P=0.203
Non-braced (n=19)	69 ± 18		67 ± 15	
Main Th-L and L				
Braced (n=5)	66 ± 8	P=0.884	54 ± 13	P=0.242
Non-braced (n=8)	67 ± 15		69 ± 18	
Th thoracic, double Th and L, Th-L thoracolumbar, L lumbar				
Values are shown in mean ± SD				

Table 3: Comparisons of the magnitude and the correction between subgroups of curve location.

Discussion

The decision to undergo surgical treatment is often very difficult for a patient and their caregivers. The decision becomes even more difficult if preventive treatment, such as bracing, is unsuccessful. The reason for this is that brace treatment involves not only financial costs, but also discomfort in everyday activities, and, finally, the belief that the therapy will be successful. In the case of these patients, the effect of prior bracing on the final outcome of treatment is unclear. In their systematic overview of clinical studies, Dolan and Weinstein aim to assess the frequency of surgical treatments preceded by observation or bracing. The mean frequency of surgeries is similar in both cases (on average, 22% after observation and 23% after bracing). Taking this into account, none of the pre-surgery methods can be indicated as being more advantageous. Based on the evidence presented in the report, neither approach can be recommended to definitively avoid surgical intervention [8]. Sun et al. reveal that patients who had previously undergone brace treatment (minimum of 1 year), and who underwent

surgery 6 weeks after the bracing had a less elastic curve than patients who had not undergone earlier brace treatment, regardless of the location of curve deformation. The authors report satisfactory correction in both groups. However, they observe that a history of brace treatment has a negative impact on the correction of scoliosis, regardless of the type of curve, less visible in main thoracic curve [3]. Wang et al. [9] indicate a small and insignificant decrease in the flexibility and correction of the primary curve after the surgical procedure in patients with a prior history of brace treatment compared to patients who had not been treated with a brace. History of preoperative brace treatment has not negative impact on postoperative self-perceived quality of life [9,3]. The presented study indicates that earlier treatment with a SpineCor dynamic brace does not have a significant effect on the amount of correction obtained through surgery. The correction observed right after the surgery in the group previously treated with a SpineCor brace was slightly larger than in the control group (71% vs. 66%), and the difference decreased 12 months after the surgical procedure (68% vs. 65%). The differences, even though they were not statistically significant, may indicate a slightly worse stabilization of curve correction in the study group compared to the control group. Moreover, both the length of brace treatment and the time of brace weaning do not significantly affect the satisfactory result of the surgery. Often, several months pass from the time the decision to have surgery is made to actually having the surgery; therefore, information about when to stop an unsuccessful preventive treatment becomes important to the patients, their caregivers and doctors. In light of the presented study, the effect of period of time between brace treatment and surgical intervention is generally insignificant as far as surgical correction. According to the authors, it is not necessary to continue brace treatment before surgery. Diab et al. [10] describe a prospective, multi-center study of patients with adolescent idiopathic scoliosis who underwent a posterior approach surgical correction of the curve and who were assessed using the SRS-30 questionnaire. They suggest that earlier brace treatment has a negative effect on the result of surgical correction of the curve in terms of pain, level of activity and satisfaction, and report a lower total SRS-30 score two years after the surgical procedure than for patients who had not undergone earlier brace treatment. According to the authors, such negative effect has to be taken into account when considering brace treatment. This study analyzes treatment with a Boston rigid brace [10]. The study conducted by Weigert et al. [4] reveals that the final outcome of the surgical correction of the curve is similar for the group of patients who had been treated earlier with a Boston brace before the surgery and in the group of patients who had not undergone such treatment. The results obtained by Weigert et al. [4] indicate that treating idiopathic scoliosis with a brace should be considered appropriate, and that surgical correction of the curve after unsuccessful bracing also gives good results. A history of brace treatment prior to surgery does not permanently reduce the quality of life of patients, which is why combining preventive treatment before surgery should not be avoided [4]. Available literature lacks information about the effect of using only the SpineCor dynamic brace on the outcome of surgical correction of scoliosis. Bracing, including dynamic brace treatment, is one of the most effective preventive treatment methods for idiopathic scoliosis [11-15]. However, some authors believe that a SpineCor brace is less effective compared to a Boston rigid brace, both in terms of prevent surgery and stopping the progression of the curve [16]. In the presented study, the outcome of surgical correction of the curve (also after one year of observation) did not depend on a history of prior preventative treatment with a SpineCor brace. Neither the duration of the treatment nor the period

between the time of brace weaning and surgical intervention had a greater or even significant effect on surgical correction [17]. However the authors want emphasize the importance of cooperation between the entire team of specialists in the treatment of idiopathic scoliosis, in particular physiotherapists and orthopedists, at such a critical moment when the decision of conducting a surgery must be made. Ciccone et al. [18] report that a strong cooperative team is significant during the treatment. In this study (Project Leonardo) physicians, care managers and patients demonstrated unanimous agreement concerning the positive impact on patient health and self-management. They also attributed the outcomes to the strong collaboration between all team members and between the physicians and the patients [18]. Such unanimity of all orthopedics specialists is also crucial. The weak point of the presented study was the lack of a homogenous group in terms of the type of surgical procedure performed-more participants in the study group underwent posterior approach surgery, which could have affected the stabilization of correction of the curve during the year of observation. Therefore, further studies should include an analysis of this factor. Apart from the results concerning the size of correction after the surgery, it is also necessary to complement the study with a subjective assessment of the quality of life of patients who underwent surgery for adolescent idiopathic scoliosis.

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