ADOLESCENT IDIOPATHIC SCOLIOSIS: SAGITAL PLANE AND LOW DENSITY PEDICLE SCREWS

ESCOLIOSE IDIOPÁTICA DO ADOLESCENTE: PLANO SAGITAL E BAIXA DENSIDADE METÁLICA DE PARAFUSOS PEDICULARES

ESCOLIOSIS IDIOPÁTICA DEL ADOLESCENTE: EL PLANO SAGITAL Y TORNILLOS PEDICULARES METÁLICO DE BAJA DENSIDAD

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ABSTRACT

Objective: To examine the sagittal curves of patients treated with CD instrumentation using exclusively pedicle screws. Methods: Image analysis of medical records of 27 patients (26 M and 1 F) with a minimum follow-up of 6 months, who underwent surgical treatment in our service between January 2005 and December 2010. The curves were evaluated on coronal and sagittal planes, taking into account the potential correction of the technique. Results: In the coronal plan the following curves were evaluated: proximal thoracic (TPx), main thoracic (TPp), and thoracolumbar; lumbar (TL, L), and the average flexibility was 52%, 52%, and 92% and the capacity of correction was 51%, 72%, and 64%, respectively. In the sagittal plane there was a mean increase in thoracic kyphosis (CT) of 41% and an average reduction of lumbar lordosis (LL) of 17%. Correlation analysis between variables showed Pearson coefficient of correlation of 0.053 and analysis of dispersion of $R^2 = <0.001$. Conclusion: The method has shown satisfactory results with maintenance of kyphosis correction in patients with normal and hyper kyphotic deformities.

Keywords: Scoliosis; Radiography; Spinal curvatures; Adolescent.

RESUMO

Objetivo: Analisar as curvas sagitais dos pacientes tratados com instrumentação de CD com uso exclusivo de parafusos pediculares. Método: Análise de prontuário de imagem de 27 pacientes (26 M e 1 F), com seguimento mínimo de 6 meses, submetidos a tratamento cirúrgico no serviço entre Janeiro 2005 e Dezembro de 2010. As curvas foram avaliadas no plano coronal e sagital, levando em consideração o potencial de correção da técnica. Resultados: Plano coronal: Avaliadas as curvas: torácicas proximais (TPx), torácicas principais (TPp) e toracolombares; lombares (TL;L), flexibilidade média de 52%, 52% e 92% e capacidade de correção de 51%, 72% e 64% respectivamente. No plano sagital observou-se aumento médio da cifose torácica (CT) de 41% e diminuição média da lordose lombar (LL) de 17%. Análise de correlação entre as variáveis demonstrou teste de Pearson (0,053) e análise de dispersão ($R^2 = <0,001$). Conclusão: O método demonstrou resultados satisfatórios com manutenção da correção da cifose em pacientes com deformidades normocifóticas e hipercifóticas.

Descritores: Escoliose; Radiografia; Curvaturas da coluna vertebral; Adolescente.

RESUMEN

Objetivo: Analizar las curvas sagitales de los pacientes tratados con instrumentación CD exclusivamente con tornillos pediculares. Métodos: Análisis de las imágenes de los registros clínicos de 27 pacientes (26 H y 1 M) con un seguimiento mínimo de 6 meses, que fueron sometidos a tratamiento quirúrgico en nuestro servicio, entre enero de 2005 y diciembre de 2010. Las curvas se evaluaron en planos coronales y sagitales, teniendo en cuenta el potencial de corrección de la técnica. Resultados: En el plan coronal se evaluaron las siguientes curvas: torácica proximal (TPx), torácica principal (TPP), y toracolumbar; lumbar (TL, L), y la flexibilidad promedio fue de 52%, 52%, y 92% y la capacidad de corrección fue de 51%, 72% y 64%, respectivamente. En el plano sagital, se produjo un incremento medio de la cifosis torácica (CT) de 41% y una reducción media de la lordosis lumbar (LL) de 17%. El análisis de correlación entre las variables mostró coeficiente de correlación de Pearson of 0,053 y el análisis de la dispersión fue $R^2 = <0,001$. Conclusión: El método mostró resultados satisfactorios con el mantenimiento de la corrección de la cifosis en pacientes con deformidades hipercifóticas y normocifóticas.

Descriptores: Escoliosis; Radiografía; Curvaturas de la columna vertebral; Adolescente.

INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is the most common spinal deformity in Brazil. It is a complex deformity involving changes of the physiological curves in the coronal and sagittal planes, and is associated with rotational deformities of the vertebrae.[1] The surgical treatment of this deformity is a challenge in orthopedic practice due to the difficulty of correcting the curves that should be considered within a three-dimensional evaluation, which has been defined as a very important factor for obtaining good clinical results in the long term.[2]

In the 1960s, Harrington[3] was the first to use spinal instrumentation to better correct deformities through the use of metal rods that promoted progressive distraction of the deformities. This author was able to achieve good results in the correction of the coronal plane curves, but achieved modest results in the management of changes in the sagittal plane. Since then, numerous spinal instrumentation techniques have appeared for adequately controlling these complex spinal deformities.

In 1978, in France, Cotrel and Dubousset[4,5] introduced the concept of a three-dimensional correction of scoliosis through the arrangement of hooks and screws combined with rods, which allowed the concavity of the deformity to be overcome, thus transforming coronal curves into sagittal curves and achieving better clinical and radiogra-

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phic results than previous methods. Moreover, due to the inherent stability of the method, such a technique dispensed the need for using any type of postoperative immobilization, which provides patients with greater comfort and convenience during the rehabilitation period. Thus, this technique rapidly gained popularity worldwide, becoming the primary method of surgical correction of AIS to the present day.[6]

The use of these principles in combination with the popularization of the use of pedicle screws, including in the thoracic vertebrae by Suk et al.,[7] theoretically improved the correction of deformities, mainly in the sagittal plane, with the improved management of thoracic kyphosis, and thereby reduced the complications associated with the postoperative dorsal plane (flat-back),[8] thus optimizing the long-term clinical and functional results.

Achieving a balanced trunk in both the coronal and sagittal planes is a major challenge in the treatment of AIS. Harmony between these parameters fosters maintenance of a stable posture with minimal effort.[9]

Given these facts, this study is necessary to add knowledge to a proper understanding of the correction of this pathology, in particular with regard to the curves in the sagittal plane in the postoperative period, in addition to documenting the experience of this institution in its treatment.

The objective of this study is to analyze the radiographic results for postoperative sagittal balance in patients undergoing surgical treatment of adolescent idiopathic scoliosis with pedicle screws according to the strategic vertebrae criteria of Cotrel-Dubousset.[4,5]

METHODS

After approval by the Research Ethics Committee of the institution (no. 216/2011), we evaluated the panoramic anteroposterior and lateral orthostatic spinal radiographs of 27 patients (26 females and 1 male) diagnosed with adolescent idiopathic scoliosis treated by the Department of Orthopedics and Traumatology, Santa Casa de Misericórdia de São Paulo, in the period from January 2005 to December 2010, who underwent deformity correction and arthrodesis by posterior approach using third generation instrumentation, according to the instrumentation principles of strategic vertebrae of the Cotrel-Dubousset criteria.[4,5]

In each case, the curves were classified according to the classifications of King et al.[10] and Lenke et al.,[11] and the angles of thoracic kyphosis (T5-T12) and lumbar lordosis (T12-sacrum)[12] of all curves present were measured, in addition to their deviation from the coronal axis according to the Cobb[14] method by an orthopedist familiar with the technique. The evaluations were performed in the preoperative radiographs and in the outpatient follow-up, with a minimum follow-up of six months.

Criteria for inclusion and exclusion

This study will include cases diagnosed with adolescent idiopathic scoliosis from the Department of Orthopedics and Traumatology, Santa Casa de Misericórdia de São Paulo, which have undergone surgical treatment with the use of pedicle screws using the strategic vertebrae criteria of Cotrel-Dubousset,[4,5] with radiographs of a good quality for making measurements.

Patients with deformities of another etiology, patients who underwent surgical treatment by other methods or with another type of implant, and those who required an anterior and posterior approach for correction of the deformity were excluded.

RESULTS

We evaluated 27 patients, 26 females and one male, with a mean age of 14.3 years (11-18 years) at the time of treatment, with a minimum follow-up period of six months, with an average of 22.07 months (8-39 months). All analyzed results are individually shown in Table 1.

Regarding the classification of curves, all patients belonged to types II and III of the King et al.[10] classification and the Lenke et al.[11] classification type I. As for the modifiers, 59% were type A for a lumbar modifier, and 85.1% were normokyphotic, with only four cases of negative thoracic modifier occurring. Of the patients included in this study, 81.5% underwent selective thoracic arthrodesis (distal T11, T12 or L1). (Figure 1)

Table 1. Demographics data and analysis of the behavior of sagittal curves.

n	Age	Sex	King	Lenke	Levels included	Sagittal Pre(°)		Sagittal Post(°)	
						T5-T12	T12-S1	T5-T12	T12-S1
1	17	F	3	1A-	T4-T12	0	-46	8	-32
2	13	F	3	1AN	T4-L1	20	-60	23	-55
3	13	F	2	1BN	T4-T12	20	-54	25	-40
4	13	F	3	1AN	T4-L1	20	-45	36	-34
5	18	F	3	1AN	T3-L1	35	-62	29	-51
6	17	F	2	1CN	T4-L1	30	-49	27	-44
7	13	F	2	1CN	T4-L1	20	-50	28	-52
8	13	F	3	1BN	T4-L1	14	-50	30	-51
9	15	F	2	1BN	T5-L1	18	-45	35	-40
10	13	F	3	1A-	T4-L1	7	-42	20	-42
11	11	F	3	1AN	T4-L1	13	-32	23	-31
12	16	M	3	1A-	T4-L1	10	-30	14	-32
13	12	F	3	1AN	T4-T12	22	-38	22	-39
14	13	F	3	1AN	T4-L1	20	-50	24	0
15	15	F	3	1BN	T5-L3	40	-40	30	-30
16	16	F	2	1BN	T5-L4	24	-45	10	-48
17	15	F	2	1BN	T3-L3	40	-60	34	-38
18	15	F	3	1AN	T5-L2	24	-32	10	-42
19	15	F	3	1A-	T4-L3	6	-51	10	-30
20	17	F	3	1AN	T4L1	16	-65	24	0
21	12	F	3	1AN	T4-L1	18	-37	20	-40
22	11	F	3	1AN	T4-L1	38	-47	26	-34
23	16	F	3	1AN	T5-L1	15	-45	22	-40
24	14	F	3	1AN	T5-L1	14	-50	23	-47
25	13	F	3	1BN	T6-L1	12	-40	26	-49
26	16	F	2	1BN	T5-L1	20	-50	60	-43
27	13	F	3	1BN	T4-L1	21	-44	19	-22
	14.3					20.4	-46.63	24.4	-37.3

The values identified in the last row of this table represent average values obtained for each variable.

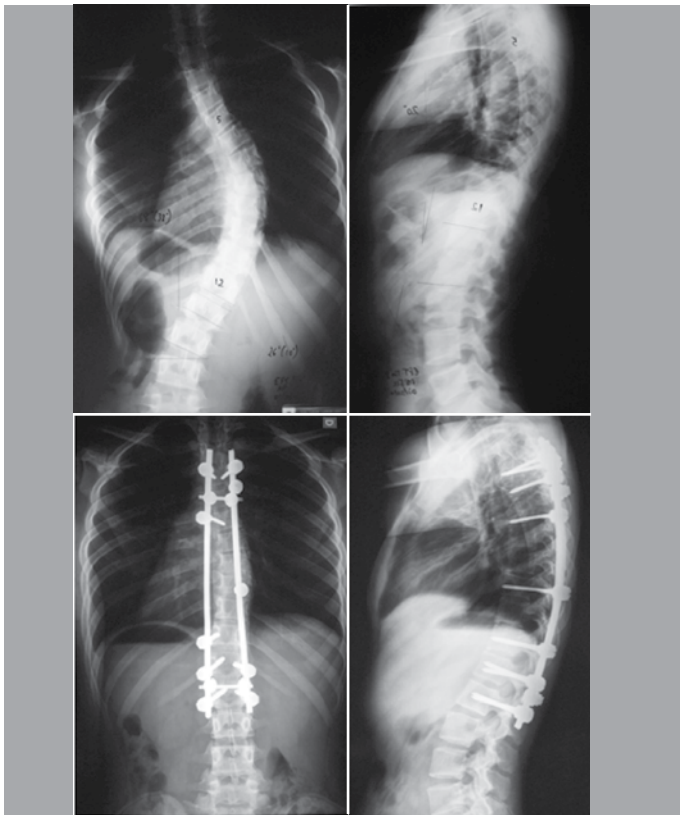

Figure 1. Case with improvement of sagittal and coronal curves after selective arthrodesis.

The radiographic analysis evaluated the curves in the coronal plane according to the Cobb[13] method, dividing them into proximal thoracic (TPx), main thoracic (TPp), and thoracolumbar/lumbar (TL/L), and the flexibility of the curve was obtained by angular analysis of the lateral inclination maneuvers. The same criteria were used in the postoperative examination to analyze the results, and the values obtained are reported in Table 2.

In the assessment of the sagittal plane, the results were analyzed in order to establish a relationship between the variation potential of this method, thoracic kyphosis (TK), and lumbar lordosis (LL). A 41% average increase in thoracic kyphosis was observed, ranging from a mean of 20.4 ± 11.40 to 24.4 ± 10.30. The analysis of lumbar lordosis showed an average reduction of 17%, ranging from an average value of -46.6 ± 8.90 to -37.2 ± 13.30. (Table 1)

When the data on the behavior of TK were correlated with the behavior of the LL, a weak correlation was obtained between the variables using the Pearson (0.053) test and scatter plot analysis ($R^2 = < 0.001$). (Figure 2)

Individual analysis of thoracic modifiers demonstrates that of the patients classified according to the Lenke et al.[11] criteria as hypokyphotic (-), 50% remained (-) after treatment, of the patients classified as normokyphotic (N), 95% remained (N) after treatment, with only one patient achieving 60° postoperative kyphosis.

Table 2. Analysis of the behavior of coronal curves.

	TPx	TPp	TL/L
Pre (°)	26.2 ± 7.1	56.2 ± 7.5	31.8 ± 11.4
Flexibility	52%	52%	92%
Post (°)	12.9 ± 6.8	15.9 ± 9.0	11.5 ± 8.2
Correction (%)	51%	72%	64%

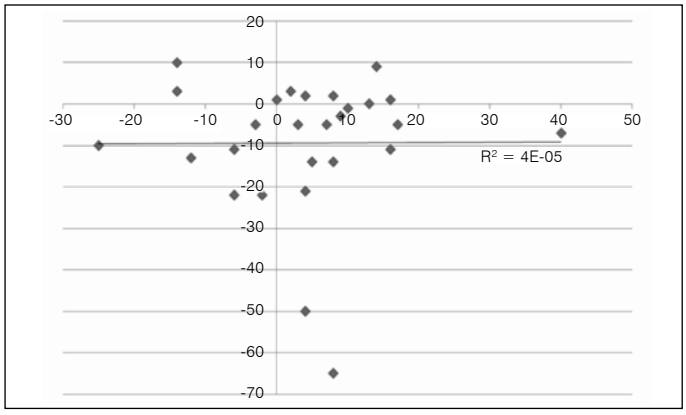

Figure 2. Correlation between the correction of TK (x-axis) and LL (y-axis). (R2 = < 0.001).

DISCUSSION

Advances in instrumentation for the treatment of AIS are evolving in an attempt to correct these deformities in three dimensions and thus avoid the known complications related to the iatrogenic flat--back syndrome,[8] common in Harrington instrumentations. The use of third-generation implants with unique instrumentation with pedicle screws provides, in theory, a support for the three spinal columns and better control of deformities in all planes.[7]

The greatest limitation of the present study is the small number of research participants, which impedes any conclusion and statistical analysis.

The correction of coronal curves in this sample demonstrates a satisfactory percentage of correction, exceeding the curve correction capability of lateral inclination maneuvers, which corroborates the idea that such a method represents a fairly consistent option for treating these deformities.[14]

As expected, the main thoracic curves showed the greatest potential for correction after surgical treatment. This fact is due to the 81.5% of patients who underwent selective thoracic arthrodesis, and it was these curves that underwent maneuvers overcoming the deformity.

The results show a weak correlation between the TK changes and the LL, but the scatter plot shows a tendency in the distribution of cases, which could potentially generate significance of the variables in a larger sample.

An average increase of the TK (41%) was also observed, and a reduction, though less significant, of LL (17%). This fact corroborates data from the literature[15] that demonstrates the same behavior of AIS surgically treated by a similar method.

The use of third-generation instrumentation exclusively with the use of pedicle screws and according to the strategic vertebrae criteria created by Cotrel and Dubousset seems to be a valid alternative for the treatment of AIS. Clinical trials in the literature demonstrate a similar capacity for the correction of deformities using this type of instrumentation when compared to the use of pedicle screws, with instrumentation of all of the vertebrae in the target curve, and thus using a smaller number of implants with the same functional and radiographic results.

When taking the value of surgical implants into account, using the smallest possible number of implants without compromising treatment is of great value as a measure of public health in our country.

In general, we can consider the treatment outcome in our sample to be favorable and comparable with the data found in the literature for this pathology.

The preservation of the sagittal silhouette, the preservation of normal kyphosis, and correction of hypokyphosis seem crucial factors for the preservation of an adequate lumbar lordosis, which in theory prevents complications from iatrogenic flat-back syndrome. This syndrome is a complication known to be related to the use of Harrington instrumentation and usually occurs in severe cases in which straightening phenomenon is markedly higher than in our study.

In order to better understand the need for the three-dimensional control of scoliotic curves with proper management of the sagittal curves, prospective controlled trials with more patients and longer term follow-up become necessary so that we can trace better goals with respect to the results of the surgical treatment of AIS.

CONCLUSION

Radiographic evaluation of the sagittal curves of adolescent idiopathic scoliosis surgically treated with pedicle screws according to the criteria of Cotrel-Dubousset demonstrated satisfactory results, with maintenance of kyphosis correction in patients with normokyphotic and hyperkyphotic deformities.

All authors declare no potential conflict of interest concerning this article.

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