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ADOLESCENT IDIOPATHIC SCOLIOSIS: PROGRESSION OF UNTREATED CASES

ESCOLIOSE IDIOPÁTICA DO ADOLESCENTE: PROGRESSÃO DE CASOS NÃO TRATADOS

ESCOLIOSIS IDIOPÁTICA DEL ADOLESCENTE: PROGRESIÓN DE CASOS NO TRATADOS

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ABSTRACT

Objective: This study aims to evaluate angular progression of patients with a diagnosis of Adolescent Idiopathic Scoliosis (AIS), that await surgical treatment. Methods: This is an observational and descriptive study. Data were collected for age at initial surgical indication, initial date and Cobb angle, date and Cobb angle of the follow-up visit, time elapsed between the initial and follow-up visit, and type of curve. All recorded Cobb angles were reviewed by the authors. Results: 86.1% of the individuals were women, the mean age of indication for surgical treatment was 13.34 years. The most common type of curve was Lenke 3 and the one that progressed the most was Lenke 4. The general average of annual progression was 9.89 degrees for the primary curves and 12.32 for the secondary curves, and the follow-up was, on average, 35.77 months. Conclusion: The progression of the magnitude of the curve increases during the wait for the definitive treatment of AIS, no matter which group of the Lenke classification the curve belongs to. The secondary curves present a progression rate of 12.32º/year, higher than the main curve, which presents a rate of 9.89º/year. The waiting time has been increasing over the years, which is evident compared to older publications. ***Level of Evidence IV; Type of Study: Prognostic Study.***

Keywords: Scoliosis; Spinal Curvatures; Spine.

RESUMO

Objetivo: Este estudo tem como objetivo avaliar a progressão do valor angular de indivíduos com diagnóstico de Escoliose Idiopática do Adolescente (EIA) não tratada, aguardando procedimento cirúrgico. Métodos: Este é um estudo observacional e descritivo. Foram coletados os seguintes dados dos pacientes: idade da indicação cirúrgica inicial, data da avaliação inicial e ângulo de Cobb, data e ângulo de Cobb nas consultas de seguimento, tempo decorrido entre as consultas inicial e de seguimento, bem como os tipos de curva. Todos os ângulos de Cobb registrados foram revisados pelos autores. Resultados: 86,1% dos indivíduos eram mulheres, a idade média de indicação de tratamento cirúrgico foi de 13,34 anos. O tipo de curva mais comum foi a Lenke 3 e a que mais progrediu foi a Lenke 4. A média geral de progressão anual foi de 9,89 graus para as curvas primárias e 12,32 para as curvas secundárias e o acompanhamento foi em média de 35,77 meses. Conclusão: A progressão da magnitude da curva aumentou durante a espera pelo tratamento definitivo da EIA, não importando em qual grupo da classificação de Lenke a curva pertence. As curvas secundárias apresentaram taxa de progressão de 12,32º/ano que é maior se comparada com a curva principal que apresenta taxa de 9,89º/ano. O tempo de espera vem aumentando com o passar dos anos, sendo evidente quando comparado com as publicações mais antigas. ***Nível de Evidência IV; Tipo de Estudo: Estudo Prognostico.***

Descritores: *Escoliose; Curvaturas da Coluna Vertebral; Coluna Vertebral.*

RESUMEN

Objetivo: Este estudio tiene como objetivo evaluar la progresión del valor angular de individuos no tratados diagnosticados con Escoliosis Idiopática del Adolescente (EIA), que están en espera de un procedimiento quirúrgico. Métodos: Se trata de un estudio observacional y descriptivo. Se recogieron datos de edad de indicación quirúrgica inicial, fecha inicial y ángulo de Cobb, fecha y ángulo de Cobb de la visita de seguimiento, tiempo transcurrido entre la visita inicial y de seguimiento y tipo de curva. Todos los ángulos de Cobb registrados fueron revisados por los autores. Resultados: El 86,1% de los individuos eran mujeres, la edad media de indicación del tratamiento quirúrgico fue de 13,34 años. El tipo de curva más común fue Lenke 3 y el que más progresó fue Lenke 4. El promedio general de progresión anual fue de 9,89 grados para las curvas primarias y 12,32 para las curvas secundarias y el seguimiento fue en promedio de 35,77 meses. Conclusión: La progresión de la magnitud de la curva aumenta durante la espera del tratamiento definitivo de la EIA, independientemente del grupo de la clasificación de Lenke al que pertenezca la curva. Las curvas secundarias presentan una tasa de progresión de 12,32º/año, superior a la curva principal que presenta una tasa de 9,89º/año. El tiempo de espera ha ido aumentando a lo largo de los años, lo cual es evidente al compararlo con publicaciones más antiguas. ***Nivel de Evidencia IV; Tipo de Estudio: Estudio Pronostico.***

Descriptores: *Escoliosis; Curvaturas de la Columna Vertebral; Columna Vertebral.*

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INTRODUCTION

Scoliosis is a spinal deformity characterized by a lateral curvature that measures more than 10 degrees on radiography.[1] This deformity is three-dimensional in which a lateral or coronal plane curvature is the main component.[2,3] It can also present with rotation of the vertebrae in the axial plane, torsion of the rib cage, and altered sagittal alignment and pelvic morphology.[3] Adolescent Idiopathic Scoliosis (AIS) begins at puberty,[4] and the diagnosis occurs in patients between the ages of 10 and 18 years, while Juvenile Idiopathic Scoliosis (JIS) begins between the ages of 3-10 years, and Infantile Idiopathic Scoliosis (IIAS) begins between the ages of 0-3 years.[5] It is a diagnosis of exclusion,[1] after eliminating all possible etiologies, such as neuromuscular diseases, tumors, trauma, and malformations. Currently, a multifactorial cause is the most accepted for its occurrence.[6]

It is prevalent in 2 to 3% of people under the age of 16,[1] reaching approximately 60,000 adolescents in the United States,[4] of whom 0.3 to 0.5% will have curvature with a Cobb angle greater than 20°.[1] Only 10% of individuals diagnosed with AIS will require treatment, and 0.1% are destined to progress to surgical procedures.[5]

Ideally, treatment is indicated on an individualized basis by evaluating several factors, including the magnitude of the curve as measured by the Cobb angle and the patient's skeletal maturity. The treatment aims to stabilize and reduce the angular value of the deformity, maintain the sagittal and coronal balance of the trunk, as well as to avoid complications that may arise with the progression of the pathology, and improve aesthetics. From a Cobb angle of 50° onwards, there is an indication for surgical approach[6] and skeletally immature individuals who reach a curvature of this magnitude tend to progress, even into adulthood, at a rate of approximately 1° per year.[4]

Once there is an indication for surgical treatment, it must be done as soon as possible. Evidence shows that spinal deformities become more severe and complex over time, and the risk of complications from the surgical procedure and associated costs increased considerably.[7] In Brazil, the average waiting time for scoliosis surgical treatment is 13 months.[7]

More severe and progressive curves are often associated with higher rates of psychosocial distress and aesthetic complaints.[5,8] Chest curves above 100° can lead to severe, though rare, pulmonary complications that can culminate in *cor pulmonale*.[5,8] When appropriately recommended, the surgical approach aims to improve the perceived quality of life, cosmetic complaints, and function (compared to other AIS groups) with few risks and low complication rates.[5,8]

The longer surgical delay may predispose additional surgeries, multiple approaches, longer surgical time, and complications such as greater blood loss, neurological deficits, and insufficient curvature correction.[9] In this scenery, this work was observed in a tertiary referral hospital of the Unified Health System with a long waiting list, and this study aims to evaluate the angular progression of cases of Idiopathic Scoliosis of Adolescents awaiting definitive surgical treatment.

METHODS

Participants

This was a descriptive observational study. It was approved by the Research Ethics Committee (CEP UNICAMP [CAAE 47943521.8.0000.5404]). Included patients with a previous diagnosis of AIS, on the waiting list for the indicated surgical treatment, and Cobb angle measured on panoramic spine radiographs during regular follow-up at the Spine Outpatient Clinic of the Hospital das Clínicas on the College of Medical Sciences of Universidade Estadual de Campinas (HC/FCM/UNICAMP), in the period from January 2008 to December 2019. Patients who had other types of scoliosis, such as congenital or neuromuscular; who were diagnosed with the condition at less than ten years of age or older than 18 years; who had no indication for surgical treatment; who had incomplete epidemiological data recorded in medical records; or who had inadequate imaging exams for Cobb angle calculations, were excluded from the study. All participants gave their written informed consent for this study.

Data Collection

A data collection form was filled out for all participants. The form contained the patient's age at the initial surgical indication and date and Cobb angle at that time, the date and Cobb angle at a follow-up visit, the time elapsed between the two visits, and Lenke's classified curve type.

The Cobb angle was measured through the angle formed between two lines perpendicular to the lines that tangent the upper endplate of the cranial terminal vertebra and the lower endplate of the caudal terminal vertebra of the curve to be measured.[10] All patients were classified according to Lenke from 1 to 6, being 1 the Main Thoracic curve, 2 the Double Thoracic, 3 the Double Main, 4 the Triple curve, 5 the Thoracolumbar/Lumbar and 6 the Thoracolumbar/Lumbar curve with Main Thoracic.[11] The authors reviewed the Cobb angles recorded in the medical records.

Statistical Analysis

The progression rate was calculated by increasing the curve (Cobb angle of the initial surgical indication subtracted from the Cobb angle at the end of follow-up) divided by each patient's follow-up time in months and then converted to degrees/year for comparison purposes. Data analysis was performed using Statistical Packages for the Social Sciences (SPSS) 28.0.0.0 (IBM, New York, USA). All data were assessed for normality using the Shapiro-Wilks tests. One-sample significance tests were used to compare the annual progression found in this study with data found in the literature according to the Iowa Series.[12] Paired t-tests were used to compare the annual progression on the primary and secondary curves, according to Lenke. Significance was set at $P < 0.05$.

RESULTS

Twenty-nine participants who met the eligibility criteria were included in this study, five males (13.4%) and 24 females (86.2%). The mean age at initial surgical indication was 13.34 ± 2.62 years, and the final age at follow-up was 17.62 ± 3.33 years. According to Lenke's classification, we get: Lenke 1 five patients (17.2 %); Lenke 2 four patients (13.8%); Lenke 3 eight patients (27.6%); Lenke 4 three patients (10.3%); Lenke 5 four patients (13.8%); and Lenke 6 five patients (17.2%). The average waiting time in the surgical queue was 2.98 years ±2.69 or 35.77 months ± 32.37, with a minimum of 1.3 months and a maximum of 124.9 months. The Cobb angle averages and the yearly progression are shown in Table 1.

The magnitude of Cobb angles for initial observation ranged from 40° - 101° in the main curves and 30° - 83° in the secondary curves; in the final follow-up period, the amplitude of the main curves was 50° - 106° for the main curves and 34° - 83° in the secondary curves.

As shown in Table 2, there was progression in 26 of the 29 curvatures studied, totaling 89.65%. In the main curves, the progressions varied from 2.4° to 31.11°, while in the secondary curves, the increase variation was from 0.16° to 20.3° during the analyzed period. The average progression of all structured curves was 11.11 ± 22.27 per year.

Table 1. Mean Cobb angles of the main and secondary curves for initial surgical indication, final follow-up, and annual progression for patients with AIS.

		Angle***	ST**	P*
Cobb angle the initial surgical indication	Main curve	57.9	14.67	-
	Secondary curves	41.45	17.12	-
Cobb angle at the end of the follow-up	Main curve	69.79	13.79	-
	Secondary curves	52.5	15.52	-
Yearly progression	Main curve	9.89	19.19	0.02
	Secondary curves	12.32	25.26	<0.01

* Significance(*P*) calculated from Iowa Series with one-sample t-tests. ** Standard Deviation. *** Angles in degrees.

Table 2. Annual progression of Cobb angle of main and secondary curves by Lenke classification.

		Angle***	SD**	P*
Lenke 1	Main curve	6.96	7.84	0.22
Lenke 2	Main curve	11.41	6.91	0.34
	Secondary curve	6.45	4.93	0.04
Lenke 3	Main curve	7.77	10.43	0.29
	Secondary curve	4.62	5.96	<0.01
Lenke 4	Main curve	34.48	58.07	0.27
	Secondary curves	37.69	63.29	0.28
Lenke 5	Main curve	5.49	3.30	0.03
Lenke 6	Main curve	3.8	7.47	0.07
	Secondary curve	16.7	31.07	0.38

* Significance (P) calculated from the mean value of progression of the main and secondary curves, from paired T-tests. ** Standard Deviation. *** Angles in degrees.

DISCUSSION

Of the individuals evaluated, 86.2% were female, which is compatible with the ratio case of 10 females to 1 male found in the literature, as well as the ratio of 84% and 89% found by Weinstein et al., respectively in 1981 and 2003.[4,12] The age of indication for the surgical procedure was 13.34 years with a SD of 2.62, similar to that found by Helenius et al. at the time of operative intervention[13] showing compatible age between the two studies on arrival at the surgical threshold.

In this sample, the curves classified as Lenke 3 were the majority, representing 27.3% of the total. However, it is worth noting that the distribution was homogeneous with the other curves in the other five subtypes of the classification, which differs from the numbers found by Rodrigues et al., where the vast majority of their 49 patients studied were classified as Lenke 1 (>60%) and only five were classified as Lenke 2, 3 or 5.[14]

In our study, 89.65% of all EIA curvatures progressed, a much higher rate than that found by Di Felice et al. at 42%.[15] The heterogeneity of both studies may account for this difference. Although the Di Felice et al. review looked at patients at younger ages, the initial Cobb observation angles were generally much lower in value, and neither study recorded skeletal maturity parameters at the beginning and end of follow-up for comparison.

Both main and secondary curves progressed in 89.65% of the cases. In contrast, the secondary curves progressed more, in angular value, than the primary curves, by a value of 12.32°/year versus 9.89°/year for the primary curves. A possible mechanism to justify the comparative increase in secondary curvatures would be the main curvature's change in spinopelvic morphology, the compensatory mechanism to maintain spinal balance, and the greater growth potential of secondary curvatures.[16] The annual progression of main curvatures was much higher than that described in the Iowa Series, in which a progression of 0.39º per year was found for main curvatures and 0.37º per year for secondary curvatures, with a significance of 0.02.[12]

The Cobb angle at the beginning of the follow-up was 57.9 ± 14.67 for the primary curves and 41.45 ± 17.12 for the secondary curves. This may account for the higher progression rates in this study, since curves greater than 50º tend to increase much more than those less than 30º.[15] Early approach in these cases is essential, since progression of the AIS curve makes the surgical procedure more difficult and increases the risk of surgical complications. Larger curves may need a combined anterior and posterior approach, allowing the spine to be defeated and correcting rib deformities with thoracoplasty. Although this is associated with more proximal junctional kyphosis, a higher risk of pseudoarthrosis, pulmonary complications, and distal disc degeneration.[17] Pedicle screw instrumentation is currently the gold standard for surgical treatment, correcting about 75% of the deformity. Generally, once indicated, treatment should be performed as soon as possible to avoid surgical complications accompanying the curve's progression.[13]

Lenke curves 4 progressed more than the others, at an annual value of 34.48°, followed by Lenke curves 2 (11.41°), 3 (7.77), 1 (6.96) 5 (4.49), and 6 (3.8), according to Figure 1. According to a meta-analysis by Di Felice et al., Lenke curves 4 also had the greatest progression, with 9.1°, followed by Lenke curves 1, 2, 5, and 6, in that order. In this study, thoracic curves progressed 8.7º per year, double curves 6.8º, lumbar curves 3.8º, and thoracolumbar curves 3.7º. In both studies, there was greater progression in the triple curves (Lenke 4) and less in the lumbar and thoracolumbar curves (Lenke 5 and 6); however, the progression value of each curve was significantly different in the two studies, which can be justified, again, by the initial Cobb angle evaluated in this study, which was 57.9 degrees in contrast to the study of Di Felice et al.,[15] If we analyze the increase of all the heterogeneously structured curves, we can reach an average of 13.10 degrees of increase every six months, which represents an increased average when compared to the study by Anh et al., who observed that in this same period, progression of more than 10 degrees occurred only in 43% of their patients.[9]

The waiting time for the surgical procedure in this study was 35.77 months, ten months longer than that found by Lima et al., who in 2011 presented a lower average at the beginning of the last decade where the wait was an average of 25.41 months.[18] In other countries, the data were significantly different. For example, in Canada, the waiting time was approximately one year,[9] while in the United Kingdom, it ranged from 5 to 9 months.[19] These data show that the Public Health System has not kept up with the needs of this population, both in terms of early screening for diagnosis and indication of early treatment for non-surgical cases, and in terms of providing subsidies for early treatment in cases with surgical indication.

The limitations encountered during the execution of this study were, markedly, the small sample size and the variable observation time among subjects that represents the current situation of a tertiary referral hospital for the treatment of scoliosis in the Brazilian Public Health System. Therefore, future studies should investigate related signs of skeletal maturity and how these signs correlate with curve progression, as well as investigate curves with lower grades and compare progression on these curves with the findings of this research.

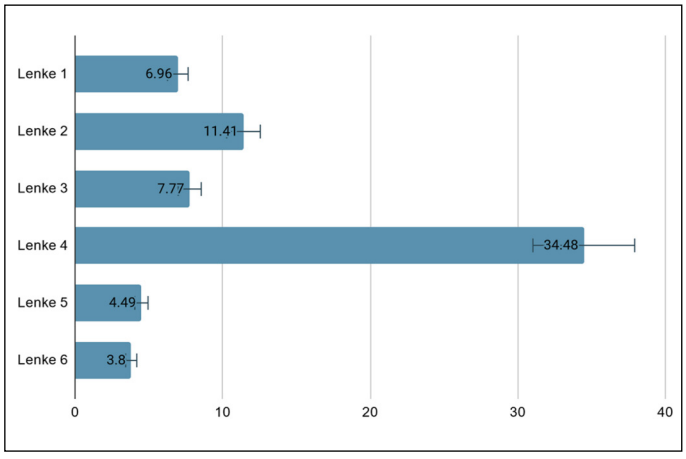

Figure 1. Annual curve progression by Lenke classification.

CONCLUSION

There was a progression of the curves in our sample during the wait for the definitive treatment of AIS, no matter which group of the Lenke classification the curve belonged to. The secondary curves showed a higher progression rate compared to the main curve. The institution's waiting time has increased over the years and is evident when comparing older publications.

All authors declare no potential conflict of interest related to this article.

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