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# COMBINED DEROTATION CORRECTION RATE IN THE SURGICAL TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS

## *TAXA DE CORREÇÃO DE DESROTAÇÃO COMBINADA NO TRATAMENTO CIRÚRGICO DA ESCOLIOSE IDIOPÁTICA DO ADOLESCENTE*

## *TASA DE CORRECCIÓN DE DESROTACIÓN COMBINADA EN EL TRATAMIENTO QUIRÚRGICO DE LA ESCOLIOSIS IDIOPÁTICA DEL ADOLESCENTE*

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## ABSTRACT

Introduction: The surgical treatment of adolescent idiopathic scoliosis (AIS) involves several maneuvers already described to align the scoliotic curve and, subsequently, vertebral derotation. Objective: The goal is to be able to achieve the greatest possible correction, thus preserving sagittal balance parameters and leaving the greatest number of mobile segments possible. The aim of the study is to verify the combined derotation technique implemented at the Reespalda Clinic and its correction rate in idiopathic scoliosis and to evaluate implant density to achieve it. Method: Observational retrospective study collected between 2021 and 2023, with a 6-month follow-up, including clinic and radiologic data. Descriptive and inferential statistics were analyzed (R 4.3.2). Derotation technique: posterior transpedicular instrumentation with intraoperative neurophysiological monitoring, inserting a rod in a proper sagittal contour on the convex side. Specialized reduction tool with loosely affixing anchors, doing a vertebral translation. Then, a global derotation with only one rod, fixing anchors. Placing the concave rod with mild hypokyphosis. Distraction on the concave side, and compression on the convex side. Results: 25 cases were totalized (no. 15 of Lenke 1, no. 5 of Lenke 3 and no. 5 of Lenke 5). Preoperative Cobb mean angle of 60.44º and postoperative Cobb mean angle of 22.22º, with a mean correction rate of 67.45º. High screw density was related to a better correction rate (p=0.0266) in Lenke 1. Meanwhile, 100% of Lenke 3 and 5 were high density. Conclusion: Combined derotation technique reached a successful correction rate; however, high-density screw was needed to achieve it. ***Level of Evidence IV; Cases of Series.***

**Keywords:** Scoliosis; Surgical instrumentation, Goals.

## *RESUMO*

*Introdução: O tratamento cirúrgico da escoliose idiopática do adolescente (EIA) envolve diversas manobras já descritas para alinhamento da curva escoliótica e posterior derotação vertebral. Objetivo: O objetivo é conseguir a maior correção possível, preservando assim os parâmetros do equilíbrio sagital e deixando o maior número de segmentos móveis. O objetivo do estudo é verificar a técnica de derotação combinada implementada na Clínica Reespalda e sua taxa de correção na escoliose idiopática, e avaliar a densidade dos implantes. Método: Estudo observacional retrospectivo coletado entre 2021 e 2023, com acompanhamento de 6 meses, incluindo dados clínicos e radiológicos. Foram utilizadas estatísticas descritivas e inferenciais (R 4.3.2). Técnica de derotação: instrumentação transpedicular posterior com monitorização neurofisiológica intraoperatória, inserindo uma haste em contorno sagital adequado no lado convexo. Ferramenta de redução especializada com âncoras sem fixação, realizando translação vertebral. Em seguida, é realizada uma derotação global com uma única haste, fixando as âncoras. Colocação da haste côncava com hipocifose leve. Distração no lado côncavo e compressão no lado convexo. Resultados: Foram totalizados 25 casos (nº 15 do Lenke 1, nº 5 do Lenke 3 e nº 5 do Lenke 5). Ângulo de Cobb médio pré-operatório de 60,44º e ângulo de Cobb médio pós-operatório de 22,22º, com taxa média de correção de 67,45º. A alta densidade de parafusos foi relacionada a uma melhor taxa de correção (p=0,0266) no Lenke 1, enquanto 100% dos Lenke 3 e 5 foram de alta densidade. Conclusão: A técnica de depreciação combinada alcançou uma taxa de correção bem sucedida, no entanto, foi necessária uma alta densidade de parafusos para conseguir isso. **Nível de Evidência IV; Série de Casos.***

***Descritores:*** *Escoliose; Instrumentação Cirúrgica; Objetivos.*

## *RESUMEN*

*Introducción: el tratamiento quirúrgico de la escoliosis idiopática del adolescente (EIA) implica varias maniobras ya descriptas para la alineación de la curva escoliótica y posteriormente la derotación vertebral. Objetivo: El objetivo es conseguir la mayor corrección posible, preservando así los parámetros del equilibrio sagital y dejando el mayor número de segmentos móviles. El propósito del estudio es verificar la técnica de derotación combinada implementada en la Clínica Reespalda y su tasa de corrección en la escoliosis idiopática, y evaluar la densidad de los implantes. Método: estudio observacional retrospectivo recolectado entre 2021 y 2023, con seguimiento de 6 meses,*

Study conducted by the Re-Espalda Foundation located at Puerta de Hierro Medical Center, Av. Adolfo López Mateos Su, Col. Las Amapas, Tlajomulco de Zúñiga, Jalisco, Mexico, Zip Code: 45640.
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*que incluye datos clínicos y radiológicos. Se utilizó estadística descriptiva e inferencial (R 4.3.2). Técnica de derotación: instrumentación transpedicular posterior con monitorización neurofisiológica intraoperatoria, insertando una varilla en un contorno sagital adecuado en el lado convexo. Herramienta de reducción especializada con anclajes sin fijación, realizando una traslación vertebral. Luego se realiza un desrotación global con una sola varilla, fijando anclajes. Colocación de la varilla cóncava con hipocifosis leve. Distracción en el lado cóncavo y compresión en el lado convexo. Resultados: Fueran totalizados 25 casos (no. 15 de Lenke 1, no. 5 de Lenke 3 y no. 5 de Lenke 5). Ángulo medio de Cobb preoperatorio de 60,44º y ángulo medio de Cobb postoperatorio de 22,22º, con una tasa de corrección media de 67,45º. La alta densidad de tornillos se relacionó con una mejor tasa de corrección (p=0,0266) en Lenke 1, mientras que el 100% de los Lenke 3 y 5 fueron de alta densidad. Conclusión: La técnica de derotación combinada alcanzó una tasa de corrección exitosa, sin embargo, se necesitó alta densidad de tornillos para conseguirlo.* ***Nivel de Evidencia IV; Serie de Casos.***

***Descriptores:*** *Escoliosis; Instrumentación quirúrgica; Objetivos.*

## INTRODUCTION

Scoliosis is a three-dimensional pediatric deformity, characterized by an angulation of more than 10º in the coronal plane.[1,2] The way to diagnose pediatric scoliosis is, in the first instance, clinical suspicion and then performing x-rays.[3] The conservative treatment of adolescent idiopathic scoliosis is when the angulation is between 25-40º, where depending on the clinical and radiological characteristics, they determine the orthosis to be used.[3,4,5] From 45-50º, the curve is considered surgical, and preoperative analysis becomes essential to determine the segments to be instrumented.[1,6,7] There are several posterior correction techniques, such as global derotation with bars, vertebral traslation, cantilever maneuver, vertebral derotation, differential rod shaping, compression/distraction, in situ shaping, halo distraction, and temporary internal distraction.[1,8,9] The global bar distraction maneuver is a technique described by Cotrel and Dubousset, which indicates that the coronal deformity is corrected towards an optimal sagittal profile when it is defeated at 90º through the use of transpedicular screws.[1,10] Initially, this type of maneuver was believed to have corrected the deformity in its three planes. However, Labelle et al. (1995) demonstrate, using magnetic fields, that correction in the axial plane is not completely achieved.[11] The vertebral translation technique allows the rigidity of the pre-molded bar to be transmitted in the desired sagittal profile, and to move the vertebral body to the expected position, using surgical instruments such as specialized reduction tools. Also, the compression/distraction maneuver[1] gives fine movements to finish adjusting the concave and convex sides of the curvature. To determine the percentage of correction obtained, not only the derotation technique must be considered, but also factors such as the instrumented levels and the density of screws to be used. The screw density is measured by dividing between the screws used and the vertebrae included in the surgery, in this way, it is considered Low Density (LD) value $<1.4$, and High Density (HD) $>1.4$.[12] Larson et al (2024),[13] determined that in EIA treated with posterior spinal instrumentation, there was no difference between low versus high screw density, in terms of coronal correction obtained in main thoracic curves between 45º and 65º. While Hwang et al. (2020),[14] establishes that in patients with scoliosis, an HD contributes to adequate correction in patients with AIS. The objective of this study is to determine the percentage of correction that patients with AIS have reached using a combined derotation technique and to correlate the density implant used to obtain correction.

## MATERIALS AND METHODS

The patients included were those with a diagnosis of AIS, under 20 years of age, curves greater than 45º, who underwent surgery between January 2021 and September 2023, and who have not been operated on previously. All the legally responsible patients who met inclusion variables and, in a free manner, had to sign an understandable informed consent (Ethics committee approval #21). In the radiological evaluation, a panoramic x-ray of the spine in coronal and sagittal projection and dynamic was requested. The type of AIS was classified according to Lenke and preoperative planning was carried out to determine the instrument levels. The surgical procedure was performed through constant neurophysiological monitoring. Posterior instrumentation with polyaxially transpedicular screws were placed. Subsequently, the derotation technique was performed: inserting a rod in a proper sagittal contour on the convex side. Specialized reduction tool with loosely affixing anchors, doing a vertebral translation. Then, a global derotation with only one rod, fixing all anchors. Placing the concave rod with mild hypokyphosis. Distraction on the concave side, and compression on the convex side, as needed. Follow-up for 6 months with x-rays controls. Annotation of the variables in an Excel table, which were sex, age, Lenke classification, instrumented levels, number of screws, screw density, preoperative Cobb of the main and compensatory curve, as well as postoperative Cobb of the main and compensatory curve. Screw density determination was classified as LD and HD. Measuring the percentage of correction using the following equation:

$$((((\text{Cobb}_{\text{postoperativex}}100)- \text{Cobb}_{\text{preoperative}})-100)x-1)$$

A descriptive analysis was made of the factors gender, age, and Lenke classification, mean of the variables age, preoperative Cobb of the main and compensatory curve, postoperative Cobb of the main and compensatory curve, correction rate mean of the principal and compensatory curve according to each Lenke classification. Using the statistical software R 4.3.2, an analysis of variance (ANOVA) was carried out on the percentage of correction of the principal curve and the density of the material used, dividing them by Lenke classification, linear regression to compare the variable correction rate of the principal curve with the instrumented vertebrae and number of screws used, as well as correction rate of the compensatory curve with the instrumented vertebrae and number of screws used.

## RESULTS

The total number of patients operated on was 25, 21 women and 4 men (Table 1), ages 11 to 20 with an average of 15 years (Table 2). Lenke's classification was found as no. 15 with Lenke type 1, no. 5 with Lenke type 3, and no. 5 with Lenke type 5 (Table 3).

Regarding the measurement of the preoperative and postoperative Cobb angle (Table 4), there was an average of 60.44º preoperative in the principal curve and an average of 37.33º in the preoperative compensatory curve. While, the mean of the postoperative principal curve was 22.22º, and the mean of the postoperative compensatory curve was 16.66º (Table 5). The correction percentages were obtained using the previously explained formula, being 67.45% for the principal curve and 63.85% for the compensatory curve (Table 6).

The linear regression Figure shows a tendency to decrease the

**Table 1.** Gender and frequency.

| Gender | No |
|---|---|
| Female | 21 |
| Male | 4 |
| Total | 25 |

**Table 2.** Mean Age.

| Age | |
|---|---|
| Mean | 15 |

correction rate in the principal curve as more levels are implemented (Figure 1). In contrast, the percentage of correction in the compensatory curve is somewhat more dispersed, but still with a tendency towards a lower percentage of correction the more levels are fixed (Figure 2). Regarding the number of screws used, it can be seen in Figure 3, there is a tendency towards less correction in the main curve, while in Figure 4 it is evident that in the compensatory curve the trend is dispersed.

Table 7 shows the ANOVA of the correlation between HD versus LD and its percentage of correction in Principal Lenke 1 curves with a significant result for HD (p=0.00266). ANOVA was not run in Lenke types 3 and 5 because 100% of the cases were HD.

## DISCUSSION

The combined technique has made it possible to treat multiple cases of idiopathic scoliosis. It can be identified that approximately 84% of the patients treated surgically for idiopathic scoliosis were female, with an average age of 15 years. Which coincides with the great statistics already mentioned throughout history.[15] There was a heterogeneous distribution in terms of the Lenke classifications, which could be a bias in the statistical analysis to be carried out. However, in the Lenke 1 classification, although there is one with a type C modifier, most are found with a lumbar type A and B modifier. Likewise, Lenke 3 has only one case with a type B modifier, and the rest are type C modifiers. The mean correction rate of the main curve was 67.45°, while for the compensatory curve, it was 63.85°, a result with which it is also heterogeneous because the three Lenke types are in the same table. Patients with Lenke 5 had the highest percentage of correction, compared to the other two. Figures 1 and 3 showed a tendency towards less correction in terms of more vertebrae instrumented and more screws being used for the main curve. While in Figures 2 and 4, the compensatory curves, the values are somewhat more dispersed, but with the same tendency that the more vertebrae and the more screws, the less the

**Table 3.** Lenke Classification and frequency.

| Lenke Classification | No |
|---|---|
| 1AN | 6 |
| 1BN | 8 |
| 1CN | 1 |
| 3BN | 1 |
| 3CN | 3 |
| 3C- | 1 |
| 5N | 5 |
| Total | 25 |

**Table 4.** Preoperative Cobb mean angle of Principal and Compensatory Curve, according to Lenke classification.

| Lenke Classification | Preoperative Cobb Principal Curve (Mean) | Preoperative Cobb Compensatory Curve (Mean) |
|---|---|---|
| I | 60.13 | 32.71 |
| 3 | 73.40 | 58.60 |
| 5 | 47.80 | 20.67 |
| Mean | 60.44 | 37.33 |

**Table 5.** Postoperative Cobb mean angle of Principal and Compensatory Curve, according to Lenke classification.

| Lenke Classification | Postoperative Cobb Principal Curve (Mean) | Postoperative Cobb Compensatory Curve (Mean) |
|---|---|---|
| 1 | 24.07 | 16.64 |
| 3 | 35.00 | 26.00 |
| 5 | 7.60 | 7.33 |
| Mean | 22.22 | 16.66 |

**Table 6.** Correction rate of Principal and Compensatory curve, according to Lenke classification.

| Lenke Classification | Correction Rate Principal Curve (Mean) | Correction Rate Compensatory Curve (Mean) |
|---|---|---|
| 1 | 64.22 | 52.27 |
| 3 | 54.33 | 55.94 |
| 5 | 83.81 | 83.33 |
| Mean | 67.45 | 63.85 |

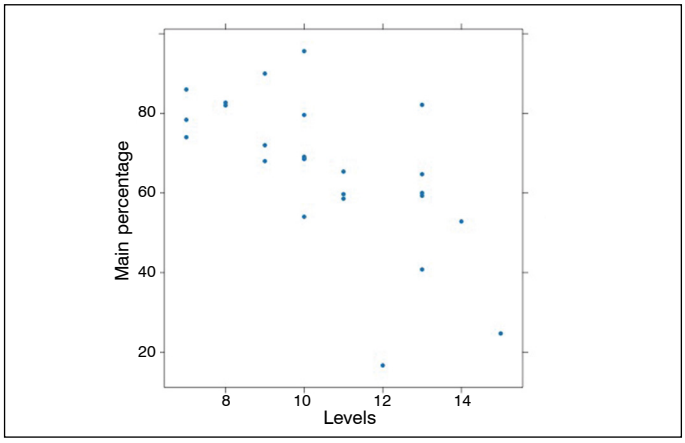


**Figure 1.** Linear regression between Correction rate (Y) of Principal curve and number of instrumented vertebrae (X).

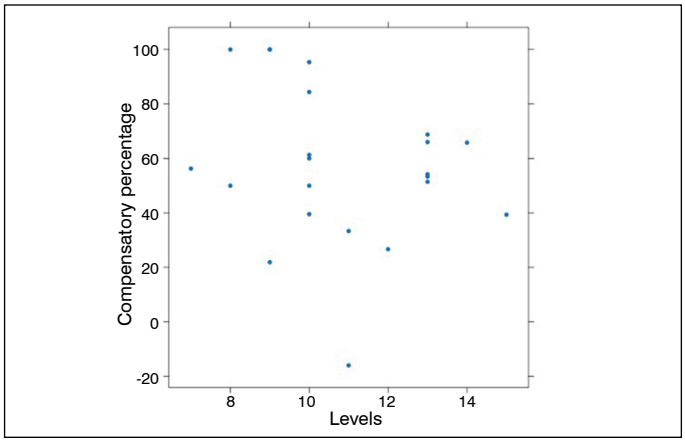


**Figure 2.** Linear regression between Correction rate (Y) of Compensatory curve and number of instrumented vertebrae (X).

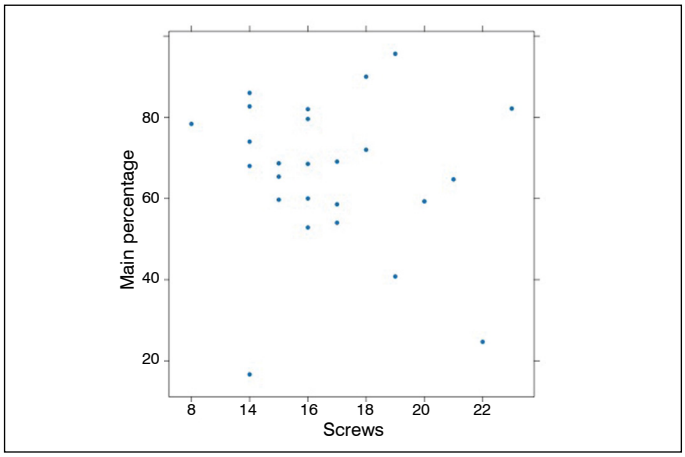


**Figure 3.** Linear regression between Correction rate (Y) of Principal Curve and number of screws used (X).

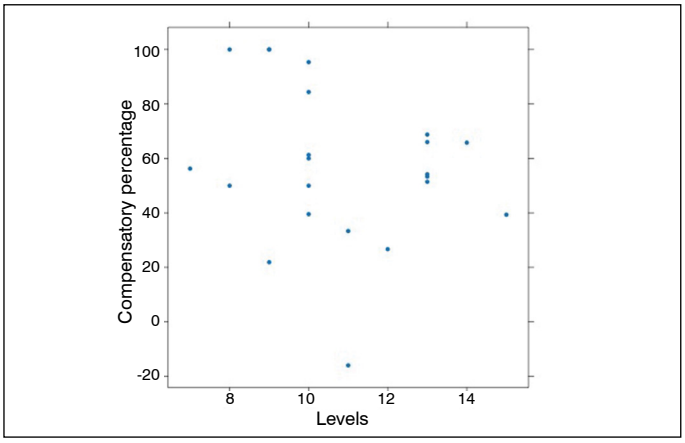


**Figure 4.** Linear regression between Correction rate (Y) of Compensatory curve and number of instrumented vertebrae (X).

**Table 7.** ANOVA of implant density (HD vrs. LD) and correction rate of Lenke 1 Principal Curve.

| | Df | Sum Sq | Mean Sq | F value | Pr |
|---|---|---|---|---|---|
| LD vs HD | 1 | 1307 | 1307 | 6.253 | 0.0266 |
| Residuals | 13 | 2717 | 209 | | |

correction. Although in this analysis, the 25 cases were combined, each point represents an individual case and its correction behavior based on the two variables (instrumented vertebrae and screws used), suggests that the trend of fewer vertebrae instrumentation and less use of screws gives better correction. However, when the ANOVA analysis is carried out between the implant density and the correction rate in the Lenke 1 classification, there is significance in those cases where an HD is used to achieve a better correction. All the Lenke 3 and 5 were HD, thus achieving an adequate correction (average correction of 53.81 in the main Lenke 3 curves and an average of 83.81 in the main Lenke 5 curves). Bharucha et al. (2013)[16] carried out a retrospective study on Lenke type 1 curves, where they concluded that there is no significant difference between HD versus LD, in terms of the correction obtained. He further highlights an approximate difference of $2,500.00 between HD and LD. Shen et al. (2017)[17] similarly conclude that there is no difference between HD and LD in correcting the deformity, but a lower bleeding rate in LD. Although the technique being used is effective for correcting the deformity, it should be considered if the derotation technique could be the cause of the use of a higher implant density.

## CONCLUSIONS

The derotation technique used has achieved effective correction rates. Although the literature defines that there is no importance between the high or low density of the material to achieve an adequate correction, the study shows a need for an AD to achieve an effective correction. Preoperative planning is of utmost importance to optimize the vertebrae that must be instrumented and try to have an AD to achieve correction. Furthermore, curves with Lenke classifications 3 and 5 have seen the need to implement 100% AD to achieve satisfactory corrections. However, carrying out a larger and more homogeneous series of cases is necessary to provide certainty to the aforementioned. Additionally, future studies include important factors such as surgical time and estimated bleeding.

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