

Classification Enguer: For Adolescent Idiopathic Scoliosis

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Abstract

Objective: To create a new, comprehensive, three-dimensional Classification for application in the evaluation of Adolescent Idiopathic Scoliosis,

Methods: The new Classification is composed of three components: The first is called the Quantitative Factor, in which the cases are divided into three types, according to number of curves. The second is the Locator Factor, which shows the most structured point of the curve. The third is the Sagittal Factor, which evaluates the sagittal plane globally.

Conclusion: As can be seen in the reported cases, the Enguer classification is a simple, informative, applicable method, which covers the 10 different radiological types of AIS.

Keywords: Scoliosis; Idiopathic; Classification; Quantitative; Sagittal; Coronal

Introduction

Adolescent Idiopathic Scoliosis (AIS) is a structured lateral curve of the spine, the cause of which is unclear. According to the Scoliosis Research Society (SRS), EIA occurs at between 10 and 17 years of age, and is characterized by curves greater than 10 degrees [1].

An adequate Classification system for Scoliosis should allow the surgeon to recommend a specific treatment, as well as permit a comparison between different treatment methods [1,2].

In addition, it should be comprehensive, and concordant for both intra and inter-observer analysis [3].

The first classification for Scoliosis was proposed by Schulthess in 1905-1907 [4].

The King Classification, originally published in 1983, evaluates the scoliotic deformity in the coronal plane, describes five types of

thoracic curves, and recommends specific levels of vertebral segments to be included in the arthrodesis [5].

The Lenke Classification system was developed in 2001, and includes three components: curve type (1 to 6), lumbar spine modifier (A, B or C) and a thoracic (-, N or +) sagittal modifier. The six types of curves have specific characteristics, viewed in the coronal and sagittal radiographs, that differentiate the structural and non-structural curves in the proximal thoracic, thoracic and thoracolumbar regions. The lumbar spine modifier is based upon the relationship between the central sacral vertical line and the apex of the lumbar curve. The sagittal thoracic modifier is based upon the sagittal curve measurement from the fifth to the twelfth thoracic levels. A minus sign (-) represents a curve of less than (+) 10 degrees, (N) represents a curve of 10 degrees to 40 degrees, and a plus sign (+) represents a curve of more than +40 degrees [6].

Vialle EM., *et al.* in 2006, presented an evaluation of 27 radiographs of patients with Adolescent Idiopathic Scoliosis, applied the Lenke Classification, and observed low intra- and interobserver reproducibility [7].

In 2008 a study was published applying the Lenke Classification in 66 cases of Adolescent Idiopathic Scoliosis (AIS). There was a greater discrepancy, with statistical significance of ($p < 0.05$), between lumbar and thoracic sagittal modifier data. This fact can be justified by the low rates of agreement and reproducibility of these variables [8].

In order to measure thoracic kyphosis, the authors consider (-) hypokyphosis curve less than 25°, (N) normal angle between 25° to 45° and (+) hypokyphosis deformity above 45° [9].

Kapandji IA, in 2000, measured lumbar lordosis of the spine by the Cobb method, obtained by drawing a straight line on the upper plateau of L1 (A) and another on the upper surface of S1 (B). Two straight lines perpendicular to these lines were drawn, and the point of intersection of these lines will form the desired angle, whose normal value varies from 40° to 60°. An angle of less than 40° indicates hypolordosis, and an angle greater than 60°, corresponds to hyperlordosis [10].

Garcia., *et al.* created a new principle of instrumentation in the surgical treatment of AIS, using short, apical, single or multiple fixations, obtaining excellent correction and trunk balance [11].

Objective of the Study

The objective of the present study was to create a new classification, which covers all AIS formats, locating the most structured curve, and including an overall assessment of the sagittal plane.

Materials and Methods

Approved project, CAAE: 68440517.8.0000.5138, Submitted by Santa Casa de Belo Horizonte, 05/17/2017.

The specialists of the Vertebral Spine Institute and the Santa Casa Vertebral Spine Group, both in Belo Horizonte, aim to create a new classification for AIS, in a manner which is quantitative, encompassing all deformities into only three basic types, structured analysis of the deformity, including an overall three-dimensional evaluation, using the angular values for kyphosis and lordosis, already pre-established in the literature [9,10].

Scoliosis was considered in this study to be curves above 10°, structured and associated with rotation.

For the study of the cases, x-rays were taken in panoramas of the spine, in the orthostatic position, in the incidences of profile, posterior-anterior and posterior-anterior with right and left slope, in order to analyze the deformity in the sagittal and coronal plane, its flexibility, and to differentiate the structured and unstructured curves.

The new classification has 3 components: Quantitative Factor, Locator Factor and Sagittal Factor.

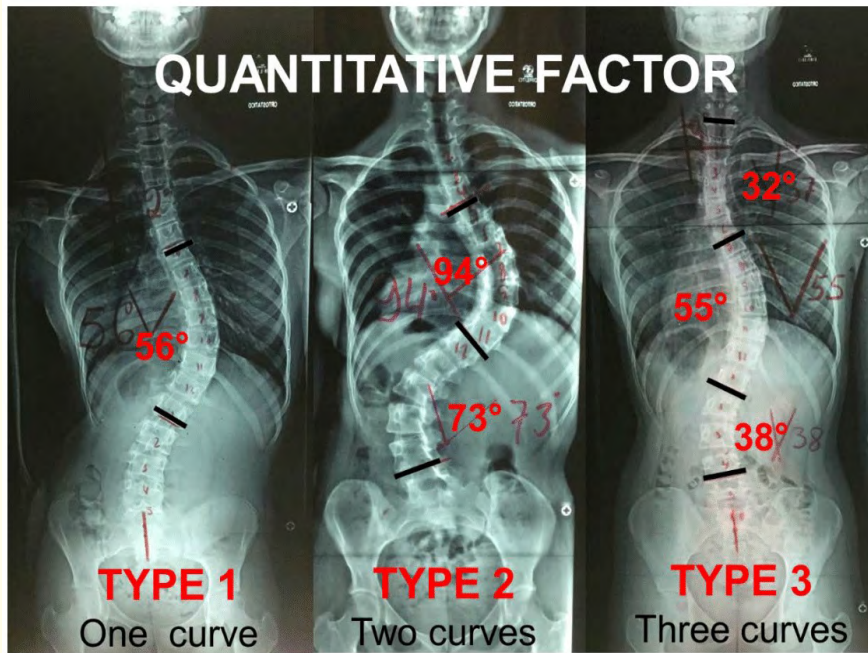


Figure 1A: First component: Quantitative Factor of the new Classification, in the image to the left is the Type I. In the center Type II. To the right is Type III.

“Quantitative Factor”: The cases are divided into 3 types of deformities: Type 1, Scoliosis with only one curve, Type 2, Scoliosis with two curves and Type 3, Scoliosis with 3 curves, see figure 1A.

“Locator Factor”: Relates to the main curve. It was divided into “A, B and C”. Type „A” is considered to be the main curve located in the proximal region of the spine, which extends from the cervical spine to T5, see figure 2. Type „B” is the most structured curve in the middle thoracic spine from T5 to T10. Type „C” is considered to be the larger curve visualized in the thoracolumbar region of T11 to S1.

LOCATOR FACTOR:

IF THE MAIN CURVE IS:

PROXIMAL CERVICOTHORACIC	> A
MEDIUM THORACIC	> B
THORACOLUMBAR	> C

Type 2B divides 2 subtypes:
 If the compensatory curve is thoracic (2BT)
 If the compensatory curve is thoracolumbar (2BL).

Figure 1B: Second component: “Locator Factor” of the new Classification.

“Type 2B” is subdivided into “2BT” when the compensatory curve is located in the proximal region and “2BL” when the compensatory curve lies in the thoracolumbar region, see figure 1B.

“Sagittal Factor”, total measurement of the sagittal plane, the Cobb method is used, approaching the entire kyphotic area, from the upper terminal vertebra to the lower terminal vertebra, and lordosis from L1 to S1.

Hypokyphosis is considered to be a curve below 25°, (N) normal angle between 25° to 45°, and (+) hyperkyphosis deformity above 45° [9].

The lumbar lordosis of the spine is also measured by the Cobb method, obtained by drawing a straight line on the upper plateau of L1 and

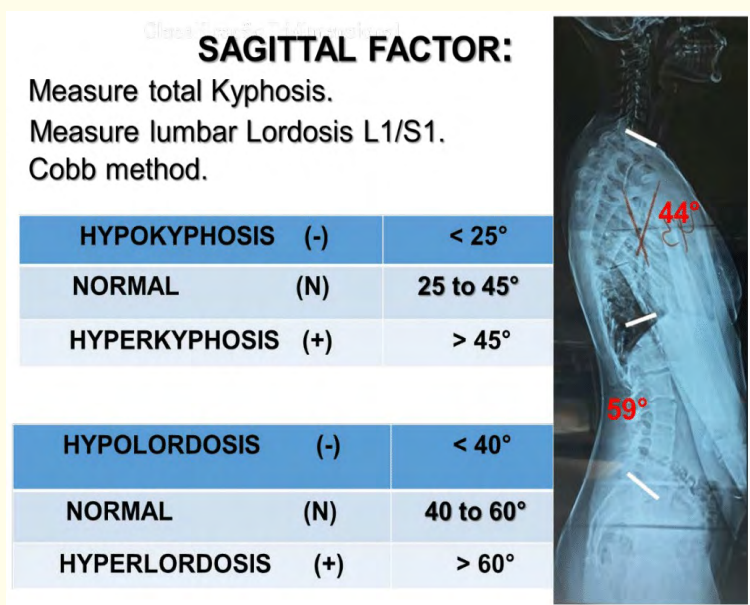


Figure 1C: Third component: “Sagittal Factor” of the new Classification.

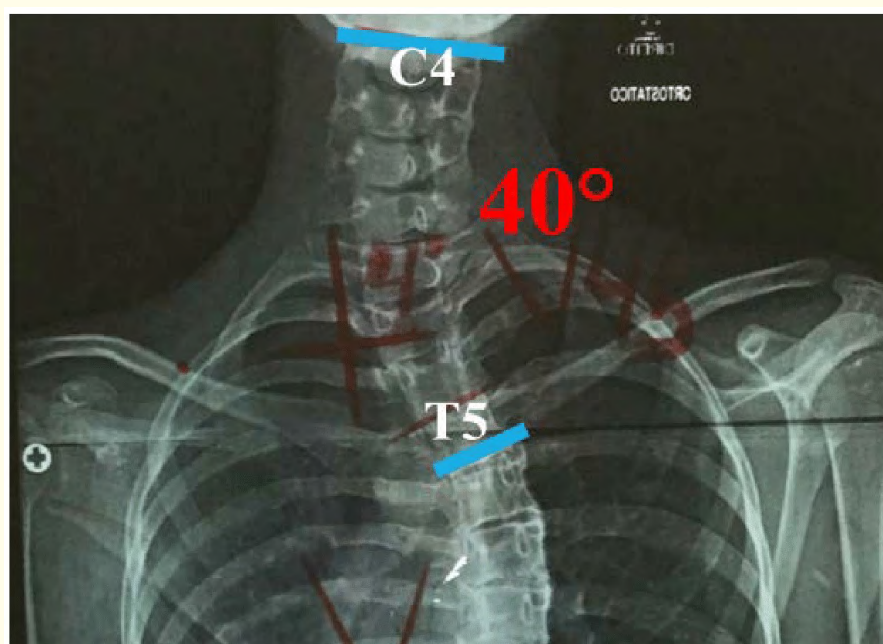


Figure 2: Radiological image of a patient of this series with AIS, showing proximal curve of 40°, measured from the two terminal vertebrae, in this case extending from C4 to T5.

another on the upper surface of S1. A line perpendicular to these two lines is drawn, forming the angle to be measured. The normal value varies from 40° to 60° (N); hypolordosis (-) when the angle is less than 40°, and an angle greater than 60° (+), corresponds to hyperlor-

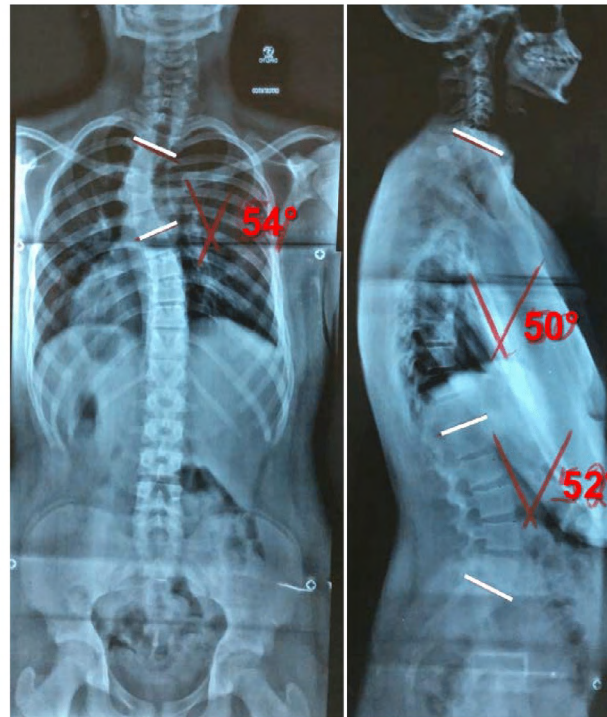


Figure 3: Left patient image with AIS, showing single, structured, proximal curve, therefore classified as “Type 1” Quantitative Factor, and Locator Factor “A”. The Rx on the right with 50° hyperkyphosis considered “+” and lordosis of 52° is normal “N”. It is classified as (1 A + N).

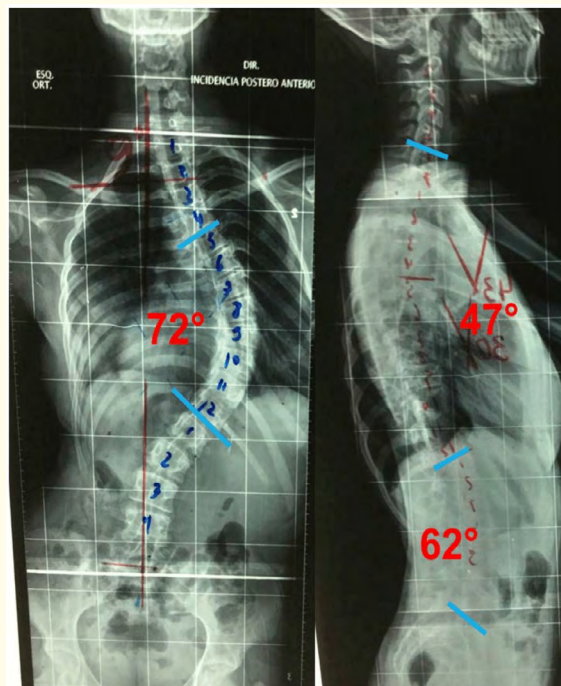


Figure 4: In the left image, AIS case, a single structured curve located in the middle thoracic spine is observed, with the Quantitative Factor “Type 1”, and the Locator Factor “B”. To the right Rx in profile, to evaluate the Sagittal Factor, shows Hyperkyphosis of 47°, which is considered “+” and Hyperlordosis of 62°, also “+”. It is classified as (1 B + +).

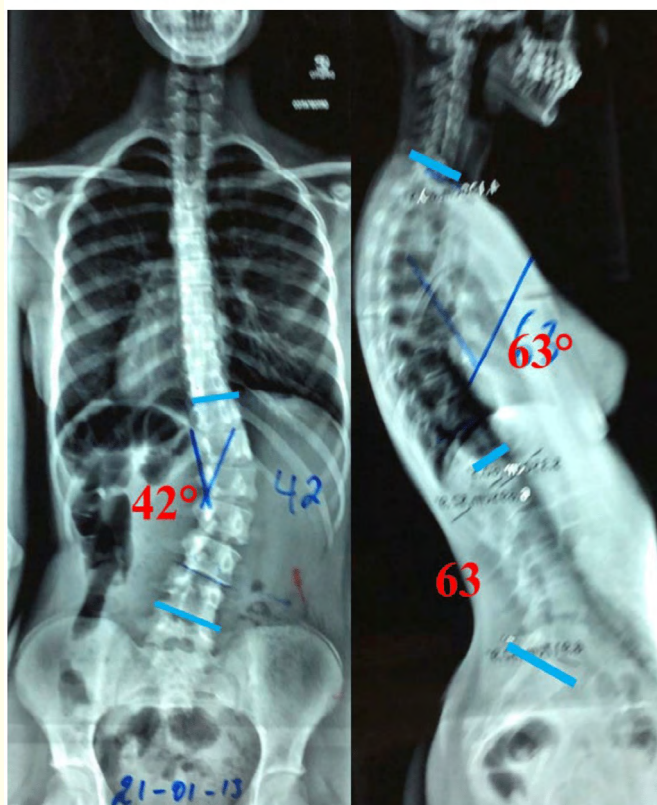


Figure 5: In the x-ray to the left, of an AIS patient with a single curve, structured, thoracolumbar level, the Quantitative Factor is considered "Type 1" and the Locator Factor "C". The image to the right, to study the Sagittal Factor, measured along the entire length of the curve, shows 63° "+" Hyperkyphosis. Hyperlordosis of 63° "+" is associated. It is classified as (1 C ++).

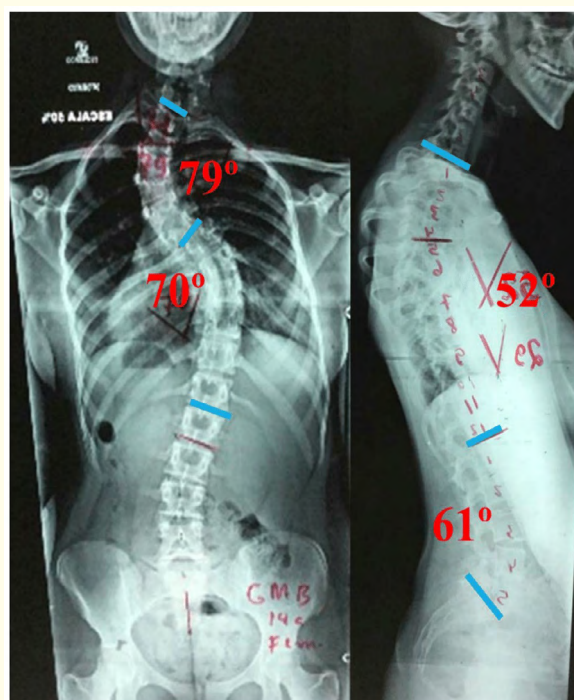


Figure 6: X-ray to the left, patient with AIS with double thoracic curve, therefore "Type 2" Quantitative Factor. Being the main to proximal curve, therefore it is considered Locator Factor "A". In the image to the right, evaluating the Sagittal Factor, it shows Hyperkyphosis of 52° "+". Hyperlordosis of 61° "+". It is classified as (2 A ++).

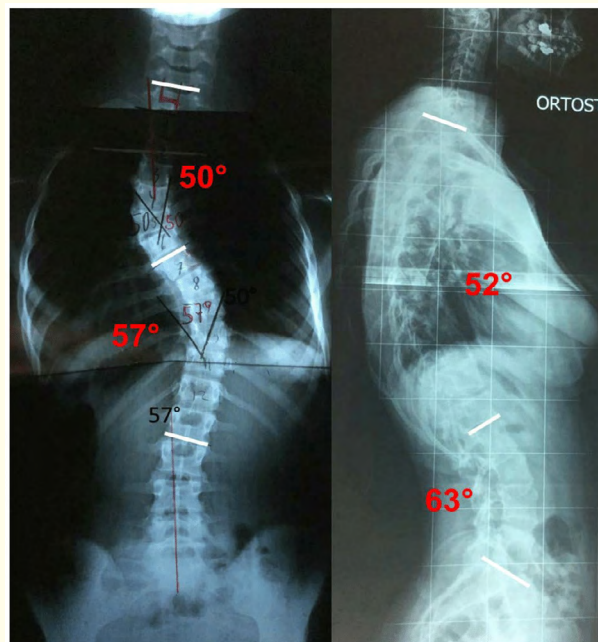


Figure 7: In the left Rx of an AIS case with two thoracic curves, Quantitative Factor “Type 2”, the main curve is in the middle thoracic, and the compensatory is the proximal curve, so the Locator Factor is “BT”. In the image at right to evaluate Sagittal Factor, Hyperkyphosis of 52° is observed, “+” and Hyperlordosis of 63°, “+”. It is classified as (2 BT + +).

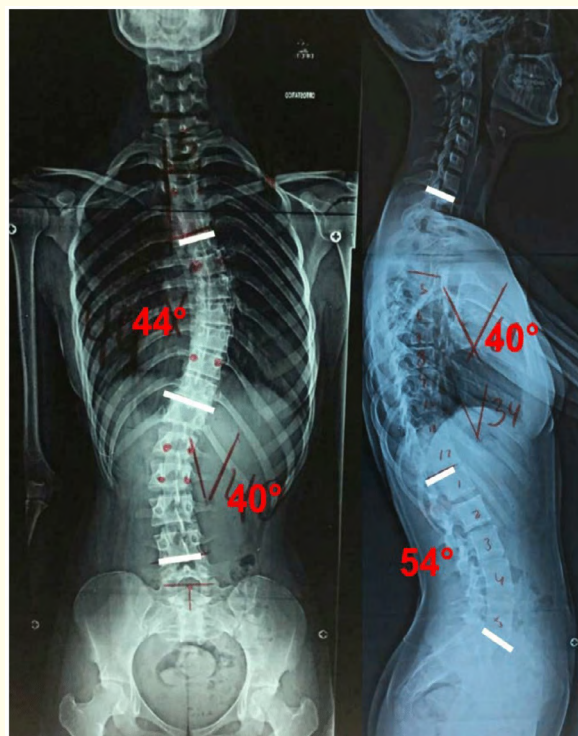


Figure 8: Left image of an AIS case, with two curves, Quantitative Factor “Type 2”. Since the main curve is the middle thoracic curve, the compensatory curve is the thoracolumbar, so the Locator Factor is “BL”. In the image to the left to evaluate the Sagittal Factor, Kyphosis of 40° is observed, “N” and Lordosis of 54°, “N”. It is classified as (2 BL N N).

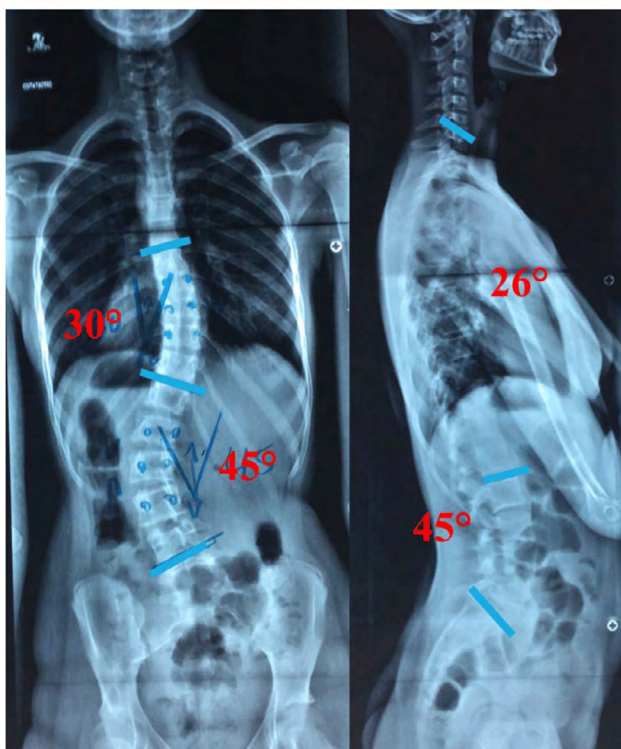


Figure 9: In the x-ray to the left a case of AIS with two curves, Quantitative Factor “Type 2”. The main curve is the thoracolumbar, so the Locator Factor is “C”. In the image to the right to evaluate the Sagittal Factor, a 26° Kyphosis was measured, equivalent to Normal “N” and Lordosis of 45°, also “N”. It is classified as (2 C N N).

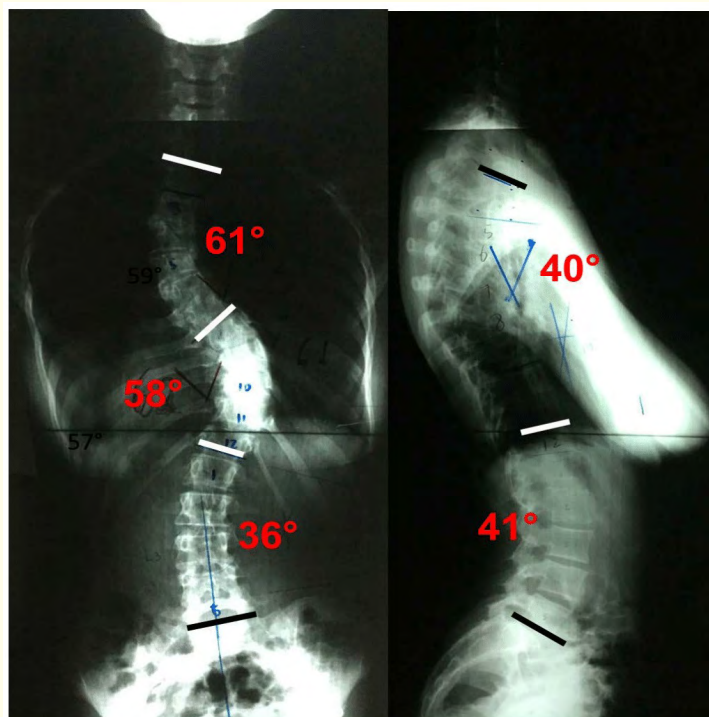


Figure 10: Image to the left of patient with AIS, presenting three curves, Quantitative Factor “Type 3”, the main curve being proximal, therefore, the Factor Localizer is “A”. In the Rx to the right, evaluating the Sagittal Factor, a 40° Kyphosis was measured, a normal “N” and a Lordosis of 41°, also normal “N”. It is classified as (3 A N N).

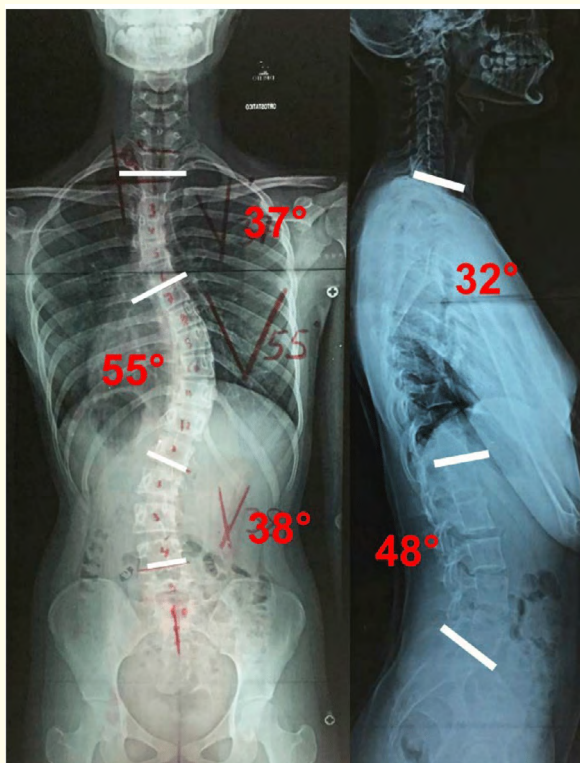


Figure 11: In the x-ray at the left, a patient with AIS, presenting three curves, Quantitative Factor "Type 3". Since the main curve is the middle thoracic, therefore, the Locator Factor is "B". In the image to the left, evaluating the Sagittal Factor, a 32° Kyphosis was measured, within normality, "N" and Lordosis of 48°, also normal "N". It is classified as (3 B N N).

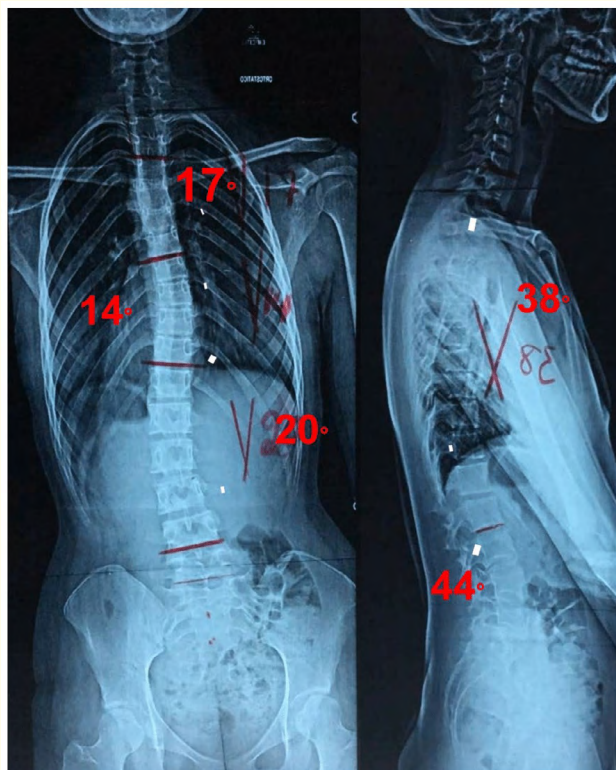


Figure 12: In the left radiological image, a patient with AIS, presenting three curves, Quantitative Factor "Type 3". The main curve being the thoracolumbar, therefore, the Locator Factor is "C". In the Rx to the right to evaluate Sagittal Factor, it showed a 38 ° Kyphosis, "N" and Lordosis of 44 °. "N". It is classified as (3 C N N).

dosis [10], see figure 1C.

The 10 different radiological types of AIS are reported, and classified according to the Enguer Classification, extracted from a database of 520 cases, see figures from 3 to 12.

Discussion

The authors of the present study, operating on a large volume of AIS patients, introduced a new principle of instrumentation, applying short, apical, single or multiple fixations [11]. As the Lenke Classification suggests fixations of any extent of the deformity considered structured [6], it did not fit this new ideology. Therefore, the new Classification was created in synch with the new technique.

In the new Classification of AIS, the proximal curve extending from the cervical spine to T5 is considered. It is recommended to measure the entire extent of this curvature, to avoid errors in surgical design and cause imbalance of the coronal plane, see figure 2.

The Lenke Classification, morphologically covers only the 6 most frequent radiological types, among the 10 basic types of AIS.

In cases of AIS with 3 curvatures, if the proximal or thoracolumbar curve is the main one, it is not classified within the Lenke method, see figures 10 and 12.

If the patient has two curves located in the thoracic spine, the main one being the proximal curve, it also does not fit within Lenke, see figure 6.

In the patient with only a structured curvature, if it is located in the proximal spine, again it does not classify within the Lenke method, see figure 3.

The Enguer Classification covers the 10 different radiological types of AIS, see figures 3 to 12.

The Lenke Classification Lumbar Modifier, identified as A, B, and C, is based upon the relationship between the central sacral vertical line and the apex of the lumbar curve. Since types 1 and 2 of this Classification do not present a curve in the coronal plane in the lumbar region, then this Modifier does not apply. Types 5 and 6 are always considered C, and in these cases the Modifier does not change. Therefore, this Lumbar Modifier applies only to types 3 and 4 [6].

In the Enguer Classification, the Locator Factor equivalent to the Lenke Lumbar Modifier, works with variables A, B, BT, BL, and C, and it applies to the 10 different radiological types of AIS, informing us of the location of the main and more structured curve.

In the Lenke Classification, to evaluate the sagittal plane, the measurement was standardized only from T5 to T12 [6], not taking into consideration the peculiarity of each curved dorsum. It is noted that frequently, the apex of kyphosis locates exactly at T5.

It is also worth noting in some images in profile, including in patients of this report, the great difficulty of visualizing T5, due to the superposition with the scapulae. Especially in cases of thoracic lordosis, see figures 3, 4, 6, 7, 10, 11.

In the Enguer Classification, the full extent of kyphosis is measured. In the opinion of the authors, it is easier to identify the terminal vertebrae of the curvature, in addition to assessing lumbar lordosis as well.

Thus the new Classification can actually be called the Three-Dimensional Classification, see figures 1C and 3 to 12.

A comparison of the new Classification with that of Lenke, in 99 cases of AIS, demonstrated very interesting results [12].

Even considering the good perspective of the Enguer Classification, further evaluation is no doubt required.

Conclusion

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