# RELIABILITY NASH AND MOE'S GRADES IN PATIENTS WITH ADOLESCENT IDIOPATHIC SCOLIOSIS

## CONFIABILIDADE DA CLASSIFICAÇÃO DE NASH & MOE EM PACIENTES COM ESCOLIOSE IDIOPÁTICA DO ADOLESCENTE

## CONFIABILIDAD DEL MÉTODO DE NASH & MOE EN PACIENTES CON ESCOLIOSE IDIOPÁTICA DEL ADOLESCENTE

David Israel de Carvalho Nascimento[1] iD, Haroldo Oliveira De Freitas Júnior[2] iD, Jefferson Soares Leal[1] iD, Ludmila Lages Ribeiro[1] iD,

Mariana Maia Lemos Barreto[1] iD, Luiz Claudio de Moura França[3] iD

1. Hospital das Clínicas da UFMG (HC-UFMG), Orthopedics and Traumatology Service, Spine Group, Belo Horizonte, MG, Brazil.
2. Hospital Mater Dei Salvador, Orthopedics and Traumatology Service, Spine Group, Salvador, BA, Brazil.
3. Hospital Mater Dei, Orthopedics and Traumatology Service, Spine Group, Belo Horizonte, MG, Brazil.

## ABSTRACT

Objective: Evaluate the inter and intra-observer reliability of Nash and Moe's grades, used to assess patients diagnosed with Adolescent Idiopathic Scoliosis (AIS). Methodology: Forty-seven representative x-rays of patients with AIS were randomly selected to evaluate the apical vertebral rotation (AVR) using Nash and Moe's grades. The evaluation of the AVR was made independently in two distinct moments by two observers. The inclusion criteria in the study were a patient diagnosed with AIS and an orthostasis radiography with a good-quality image. An agreement study between the evaluations and the inter and intraobserver's reliability was determined using Kappa's statistics with a confidence interval of 95%. Results: The interobservers' Kappa's value in the first evaluation was 0,44 (CI 95%; 0,22-0,66) and 0,37 (CI 95%; 0,17-0,56) in the second. In the intraobservers' evaluations, the Kappa's value for examiner 1 was 0,61 (CI 95%; 0,40-0,81) and 0,46 (CI 95%; 0,22-0,70) for examiner 2. Conclusion: This study's results demonstrated that Nash and Moe's grades are unreliable for evaluating vertebral rotation in patients with AIS. ***Level of Evidence III; A Cross-Sectional Study.***

Keywords: Spine; Scoliosis; Spinal Curvatures; Panoramic Radiography; Adolescent.

### RESUMO

*Objetivo: Avaliar a confiabilidade inter e intraobservador da classificação de Nash & Moe, usada em pacientes diagnosticados com escoliose idiopática do adolescente (EIA). Metodologia: Quarenta e sete radiografias representativas de pacientes com EIA foram selecionadas aleatoriamente para avaliação da rotação da vértebra apical (RVA), usando a classificação de Nash & Moe. A avaliação do RVA foi realizada de forma independente em dois momentos distintos, por dois examinadores. Os critérios de inclusão no estudo foram: paciente com diagnóstico de EIA e radiografia realizada em ortostase, com imagem de boa qualidade. Foi realizado um estudo de concordância entre as avaliações, e a confiabilidade inter e intraobservador foi calculada utilizando a estatística de Kappa com intervalo de confiança (IC) de 95%. Resultados: O valor de Kappa interobservador na primeira avaliação foi de 0,44 (IC 95% de 0,22-0,66) e na segunda de 0,37 (IC 95% de 0,17 -0,56). Nas avaliações intraobservadores, o valor de Kappa para o examinador 1 foi de 0,61 (IC 95% de 0,40-0,81) e para o examinador 2 foi de 0,46 (IC 95% de 0,22-0,70). Conclusão: Os resultados deste estudo demonstraram que a classificação de Nash & Moe apresenta baixa confiabilidade na avaliação do grau de rotação vertebral em pacientes com EIA. **Nível de Evidência III; Estudo Transversal.***

*Descritores: Coluna Vertebral; Escoliose; Curvaturas da Coluna Vertebral; Radiografia Panorâmica; Adolescente.*

### RESUMEN

*Objetivo: Evaluar la confiabilidad inter e intraobservador para la clasificación de Nash & Moe, usada para estudiar pacientes diagnosticados con Escoliosis Idiopática del Adolescente (EIA). Metodología: Cuarenta y siete radiografías representativas de pacientes con EIA fueron seleccionadas aleatoriamente para evaluación de la rotación de la vértebra apical (RVA) usando la clasificación de Nash & Moe. La evaluación fue hecha de modo independiente en dos momentos distintos, por dos evaluadores. Los criterios de inclusión en el estudio fueron: paciente con diagnóstico de EIA y radiografía realizada en ortostasis, con buena calidad de imagen. Se realizó un estudio de concordancia entre las evaluaciones y se calculó la fiabilidad interobservador e intraobservador mediante la estadística de Kappa con un intervalo de confianza (IC) del 95%. Resultados: El valor Kappa interobservador en la primera evaluación fue de 0,44 (IC 95%: 0,22-0,66) y en la segunda de 0,37 (IC 95%: 0,17 -0,56). En las evaluaciones intraobservador, el valor Kappa para el examinador 1 fue de 0,61 (IC 95%: 0,40-0,81) y para el examinador 2 fue de 0,46 (IC 95%: 0,22-0,70). Conclusión: Los resultados de este estudio demostraron que la clasificación de Nash & Moe tiene una baja fiabilidad para evaluar el grado de rotación vertebral en pacientes con EIA. **Nivel de Evidencia III; Estudio Transversal.***

*Descriptores: Columna Vertebral; Escoliosis; Curvaturas de la Columna Vertebral; Radiografía Panorámica; Adolescente.*

## INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a complex deformity involving coronal, sagittal, and axial plane alterations.[1,2] The Cobb angle, analyzed in the coronal plane, is a principal parameter used to define prognosis and treatment for AIS.[3,4] However, the importance of the axial plane, assessed by the degree of vertebral rotation, has been increasingly demonstrated as an important parameter for prognosis and patient satisfaction with treatment results.[1,2,5-7]

Due to its simplicity, the Nash & Moe classification is the most widely used method for assessing vertebral rotation.[1,8,9] This method consists of an anteroposterior (AP) radiographic assessment of the spine, in which vertebral rotation is measured according to vertebral pedicle position about the lateral margin of the curve's convexity. However, despite the widespread use of the Nash & Moe classification, few studies have evaluated its reliability in the course of AIS treatment.[10-12]

This study assesses the reliability of the Nash & Moe classification used in patients diagnosed with and undergoing treatment for adolescent idiopathic scoliosis.

## METHOD

A reliability study of the Nash & Moe classification was carried out on patients admitted between 2017 and 2021 to a service for treating AIS. The study was approved after analysis by the ethics committee (CAAE 44775621.1.0000.512). All patients admitted had their personal, anthropometric, and clinical data recorded in a spreadsheet; all radiographs were scanned, stored, and saved in a digital file bank, and all signed an Informed Consent Form. Of 138 patients admitted, 47 were randomly selected for image analysis. The inclusion criterion for the study was the availability of a good quality AP panoramic radiograph in orthostasis with clear visualization of the entire spine and vertebral anatomical landmarks in patients diagnosed with AIS.

The rotation degree of the apical vertebra (AVR), i.e., the vertebra furthest from the midline in the coronal plane, was assessed independently by two examiners. Both examiners were trained in the classification process using the Nash & Moe method, and a manual of procedures was made available as a calibration measure to avoid distortions in measurements due to the use of different classification criteria. Using vertical auxiliary lines, the apical vertebra is first divided in half, and then the convex side half is divided into three equal segments. Rotation is based on the location of the pedicle on the convexity side of these three segments. The degree of vertebral rotation is graded from 0 to 4: Grade 0 - No asymmetry; Grade 1 - The pedicle of the convexity migrates within the first segment, with little distortion; Grade 2 - The pedicle of the convexity migrates to the second vertebral segment; Grade 3 - The pedicle of the convexity reaches the midline, contained by the third segment; Grade 4 - The pedicle of the convexity goes beyond the midline, reaching the vertebral half of the concavity.

The selected images were sent to each of the examiners, and they were asked to define the apical vertebra, classify the rotation of the apical vertebra in terms of its rotation (Nash & Moe) (Figure 1), and classify the topography of the main curve of the deformity. After three months, the same images with the randomized identification order were returned to the same examiners to measure intraobserver agreement. Randomizing the order of the differently numbered images was used to reduce the memory bias of the first analysis. Only the lead investigator knew the real identification of each image. The data was tabulated and analyzed by the principal investigator, who calculated inter- and intra-observer reliability using the Kappa statistic with a 95% confidence interval (CI) and a significance level of 5% (0.05).

Analyses of the agreement between the selection of the apex of the curve and the topographic classification of the curve were carried out to support possible failures on the part of the examiners in the process of classifying vertebral rotation.

## RESULTS

In intraobserver evaluations, the Kappa value for examiner 1 was 0.61 (95% CI 0.40-0.81) and for examiner 2, 0.46 (95% CI 0.22-0.70) (Figure 2). The interobserver Kappa value for the first evaluation was 0.44 (95% CI 0.22-0.66) and for the second, 0.37 (95% CI 0.17-0.56) (Figure 3). The concordance analyses for the Nash & Moe classification, the selection of the apical vertebra, and the topographic classification are shown in Table 1. All the analyses showed a statistical significance level of less than 0.05. The results on the classification of vertebral rotation by Nash & Moe and the choice of AVR by the examiners are detailed in Tables 2 to 5.

## DISCUSSION

Assessment of the axial plane of AIS, with rotation of the apical vertebra as its most important parameter, has attracted increasing interest in recent years.[1,2,5-7,9,13] The degree of vertebral rotation can be useful for monitoring the progression of scoliosis and assessing treatment results.[5,14-16] Accurate assessment of vertebral rotation allows prediction of curve progression, the degree of correction, and possible decompensation of the coronal balance of the spine in the postoperative period.[5,6] Behensky et al.,[6] in a retrospective review of Lenke type 3C AIS, concluded that rigid rotational deformity of the lumbar curve (vertebral rotation correction of less than 40% in the slopes) results in coronal imbalance in the postoperative follow-up in
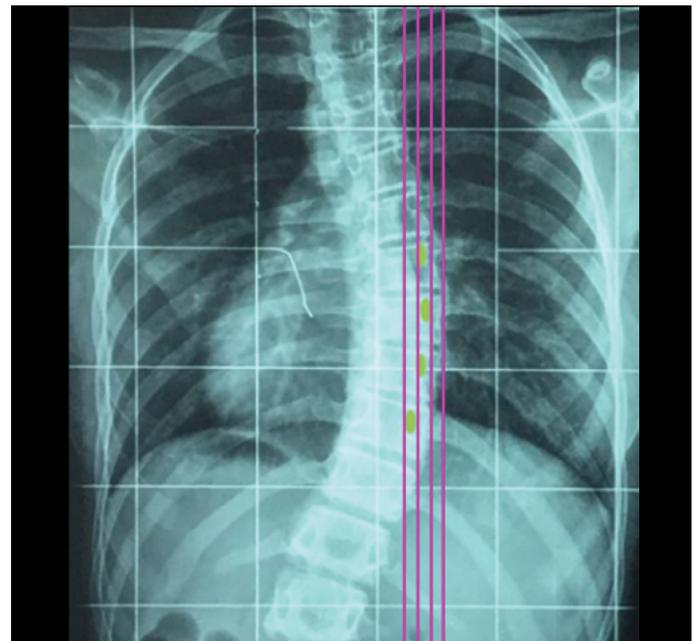


**Figure 1.** Example of analysis carried out by the examiners. On a radiograph of a patient with scoliosis, pedicles were marked on the convexity of the main curve and the rotational classification of the apical vertebra using the Nash & Moe method.
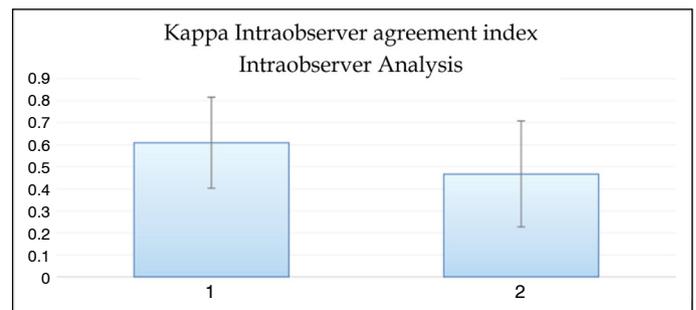


**Figure 2.** The intraobserver agreement index was found in this study after evaluations by examiners 1 and 2.
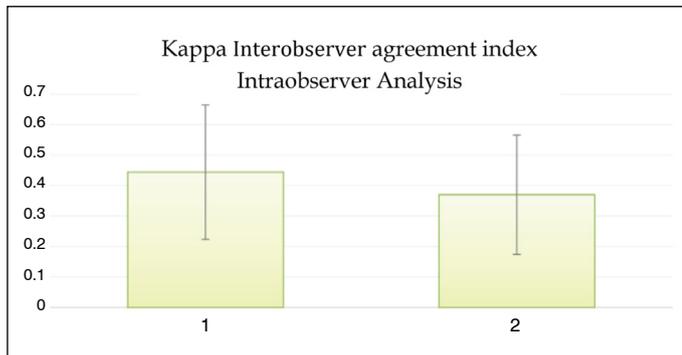
**Figure 3.** The interobserver agreement index found in this study between the examiners' assessments at moments 1 and 2.

**Table 1.** Kappa Agreement Index for Intraobserver and Interobserver evaluations

| | | | Kappa | P-valor | Lim. Inferior | Lim. Superior |
|---|---|---|---|---|---|---|
| Intraobserver | Observer 1 | Nash & Moe | 0,609 | <0,001 | 0,403 | 0,816 |
| | | Apical Vertebra | 0,73 | <0,001 | 0,594 | 0,867 |
| | | Topografic | 0,921 | <0,001 | 0,814 | 1,028 |
| | Observer 2 | Nash & Moe | 0,467 | <0,001 | 0,226 | 0,707 |
| | | Apical Vertebra | 0,48 | <0,001 | 0,316 | 0,644 |
| | | Topografic | 0,691 | <0,001 | 0,471 | 0,912 |
| Inter | Evaluation | Nash & Moe | 0,444 | <0,001 | 0,224 | 0,665 |
| | | Apical Vertebra | 0,63 | <0,001 | 0,475 | 0,784 |
| | | Topografic | 0,439 | <0,001 | 0,214 | 0,664 |
| | Revaluation | Nash & Moe | 0,37 | 0,001 | 0,174 | 0,566 |
| | | Apical Vertebra | 0,48 | <0,001 | 0,319 | 0,642 |
| | | Topografic | 0,285 | 0,017 | 0,06 | 0,51 |

**Table 2.** Classification by examiners 1 and 2 of the AVR by the Nash & Moe method of the 47 selected radiographs - moment 1.

| AVR classification by Nash & Moe | | Examiner 2 | | |
|---|---|---|---|---|
| | | 1 | 2 | Total |
| Examiner 1 | 0 | 2 | 0 | 2 |
| | 1 | 18 | 2 | 20 |
| | 2 | 10 | 15 | 25 |
| | Total | 30 | 17 | 47 |

**Table 3.** Classification by examiners 1 and 2 of the AVR by the Nash & Moe method of the 47 selected radiographs - moment 2.

| AVR classification by Nash & Moe | | Examiner 2 | | | |
|---|---|---|---|---|---|
| | | 0 | 1 | 2 | Total |
| Examiner 1 | 0 | 0 | 2 | 1 | 3 |
| | 1 | 2 | 18 | 0 | 20 |
| | 2 | 1 | 11 | 12 | 24 |
| | Total | 3 | 31 | 13 | 47 |

**Table 4.** Classification by examiner 1 of the AVR by the Nash & Moe method of the 47 radiographs selected at moments 1 and 2.

| AVR classification by Nash & Moe - Examiner 1 | | Reassessment | | | |
|---|---|---|---|---|---|
| | | 0 | 1 | 2 | Total |
| Evaluation | 0 | 1 | 1 | 0 | 2 |
| | 1 | 2 | 15 | 3 | 20 |
| | 2 | 0 | 4 | 21 | 25 |
| | Total | 3 | 20 | 24 | 47 |

selective thoracic fusions. Therefore, accurate estimation of vertebral rotation can avoid unnecessary surgery and its consequent risks.[7]

Several authors recommend including the rotational profile of the scoliotic curve in the routine assessment of AIS to better describe the three main dimensions of the deformity.[1,2,15,16] However, the most commonly used method for rotational assessment, the Nash & Moe classification, is poorly founded in terms of reliability and reproducibility to justify its widespread use. Knowledge of the reliability and reproducibility of a measure makes it possible to determine whether the effect of an intervention is greater than the variability of the measure itself and, therefore, whether it is real.[14,17]

Marawar et al.,[13] in an experimental study using synthetic models of vertebrae, found low agreement of the Nash & Moe classification (38.2% - 53.9%) compared to the Upasani method (76.74% - 80.23%). Kuklo et al.,[7] using digital measurements, found only fair interobserver reliability (r= 0.53-0.59).[7] In a cadaveric study, Chi et al.,[12] observed inferior Nash & Moe classification performance compared to the Perdriolle and Stokes methods in various tests. Mohanti et al.[18] found an interobserver agreement of 0.61.

This study assessed the reliability of the Nash & Moe classification based on routine radiographs of patients being treated for AIS. According to Landis and Koch's interpretation, Kappa values, both in the interobserver and intraobserver evaluation, ranged from poor to fair (Tables 1 and 6).[11] This study showed low reliability of the Nash & Moe classification, in line with the findings of Kuklo et al.,[17] and the results of Marawar et al.[13] and Chi et al.,[12] in their experimental studies.

This study has limitations. This is a model for evaluating a diagnostic test in which the main event studied was vertebral rotation, the evaluation of which suffers variations related to image quality, anatomical variations of the vertebrae with rotation, as well as factors inherent to the examiners when choosing the degree of classification, as well as possible memory bias in intra-observer evaluations.

**Table 5.** Classification by examiner 2 of the AVR by the Nash & Moe method of the 47 radiographs selected at moments 1 and 2.

| AVR classification by Nash & Moe - Examiner 2 | | Reassessment | | | |
|---|---|---|---|---|---|
| | | 0 | 1 | 2 | Total |
| Evaluation | 1 | 2 | 25 | 3 | 30 |
| | 2 | 1 | 6 | 10 | 17 |
| | Total | 3 | 31 | 13 | 47 |

**Table 6.** Interpretation of Kappa values according to Landis and Koch.[11]

| Kappa value | Concordance |
|---|---|
| < 0.00 | Poor |
| 0.00 – 0.20 | Weak |
| 0.21 – 0.40 | Sufferable |
| 0.41 – 0.60 | Regular |
| 0.61 – 0.80 | Good |
| 0.81 – 0.99 | Great |
| 1.00 | Perfect |

The low reliability of the Nash & Moe classification observed in this study suggests that the method should be improved or replaced by another, that is more reliable but with the same simplicity. The authors suggest that new studies be conducted along these lines.

## CONCLUSION

The results of this study showed that the Nash & Moe classification has low reliability in assessing the degree of vertebral rotation in patients being treated for AIS.

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

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