Original Article

Cobb's Method For Quantitative Evaluation Of Spinal Curvature: A Review

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Abstract

Spinal curvature is one of the most crucial parameters for the spine, but because of our ad hoc search behaviors, the similarities between healthy and unhealthy states, and the biological variability of human anatomy, we are only partially capable of quantitatively assessing spinal curvature from medical images. Applying specially designed approaches for the quantitative measurement of spine curvature is essential for improving medical diagnosis, treatment, and management of spinal issues. The Cobb method has long been favoured because of its superior reproducibility, easier application, and identification of larger angles for more extreme spine curvatures. The data used in the current study was gathered from a number of online resources, including research articles and publications from research books. The acquired information claims that the Cobb approach has mostly shown to be the most trustworthy when compared to other 2D methods. This review is an attempt to discuss the overall views pertaining to Cobb's method for quantitative evaluation regarding spinal curvature.

KEYWORDS: Cobb, spinal curvature, spine, lumber lordosis, scoliosis.

INTRODUCTION:

Quantitative examination of spinal curvature is useful for planning orthopaedic surgical procedures, monitoring the emergence and treatment of spinal anomalies, and creating reference values under healthy and sick conditions. Spinal curvature is one of the most crucial parameters for the spine, but because of our ad hoc search behaviours, the similarities between healthy and unhealthy states, and the biological variability of human anatomy, we are only partially capable of quantitatively assessing spinal curvature from medical images. Although two-dimensional (2D) images are still often utilised in clinical examinations, new three-dimensional (3D) imaging techniques have been developed as a result of advancements in medical technology and are now crucial clinical instruments in contemporary healthcare. It is necessary to provide methods for verifying the reliability and accuracy in order to assess their medical significance and potential applications. Applying specially developed methodologies for the quantitative evaluation of spine curvature is essential for improving medical diagnosis, treatment, and management of spinal problems. A crucial postural factor that has long piqued the interest of both doctors and researchers is lumbar lordosis.

Cobb proposed a method in which the deformity was identified by the angle created by the two straight lines that, respectively, run parallel to the superior and inferior endplates of the superior and inferior end vertebra. The Cobb angle is frequently used for quantitative evaluation of the lateral curvature of the spine in the frontal plane and is typically regarded as the gold standard for diagnosis and follow-up of patients with scoliosis. It was first proposed by the American orthopaedic surgeon John Robert Cobb.[1] This measurement is useful for gauging the severity of the curvature, monitoring and treating spine deformities, and planning surgical procedures.[2] The Cobb method has been traditionally adopted in clinical practice as a simple and well-known technique.[3,4]

COBB METHOD

The Cobb angle reflects changes in the inclination of the end vertebrae rather than the translation of the apical vertebra that occurs in scoliosis. The Cobb method has long been favoured because of its higher reproducibility, easier application, and detection of larger angles for more extreme spine curvatures. When the Cobb angle is less than 10 degrees, the condition of a spine is related to the spinal curvature rather than scoliosis. Mild scoliosis is defined as a Cobb angle of between 10 and 20 degrees. When the Cobb angle is between 20 and 40 degrees, the degree of scoliosis is considered to be moderate. Scoliosis is severe when the Cobb angle is greater than 40 degrees.[5] The Cobb approach yields a wide lordosis range. Cobb claims that the range of lumbar lordosis is 40° to 60°, with an angle of less than 40° denoting rectification and more than 60° denoting hyperlordosis.[6]

In a review, Been and Kalichman point out that it's possible for people to have the same Cobb angles even though their lordotic curvatures are of different sizes.[7]

The Scoliosis Research Society (SRS) approved it in 1966, making it the accepted technique for estimating scoliotic abnormalities. It is still the technique most frequently employed today to measure spine curvature. Since the Cobb method has been standardized, numerous studies have looked at its repeatability and/or reliability in evaluating idiopathic and congenital scoliosis.[8,9,10,11,12,13,14] The consensus is that a measurement must alter by 5° in order to accurately reflect a change in spinal curvature. Goldberg et al. concluded that the Cobb angle can be utilised as a trustworthy clinical classifier of adolescent idiopathic scoliosis after demonstrating that its variability tends to increase while evaluating minor curvatures.[15] The errors in the Cobb angle measurements were 5°, 8°, and 10° accurate, respectively, with confidence ranges of 30, 90, and 95%, according to Carman et al; the intra-observer error was the main contributor.[16]

Scholten and Veldhuizen reported a 3° inaccuracy in the Cobb angle when the plane of the scoliotic deformity was not parallel to the radiography projection plane and provided a mathematical model for the Cobb and Ferguson angle.[17] Additionally, they claimed that axial vertebral rotation was the cause of both results and that the Ferguson and Cobb angles were typically smaller than the true spatial angle.

Methods aided by computer algorithms were developed in order to increase the accuracy and dependability of the Cobb angle readings. In order to create a polygonal arc that roughly matched the scoliotic curve, Jeffries et al. digitalized the manually detected centres of concavities at each lateral vertebral body wall on anteroposterior radiographs.[18] Lines tangent to the curve were generated at the apical and at the end vertebrae.

According to Dutton et al.'s study on a strong correlation between manual and automated Cobb angle measurements, the reliability and repeatability of computed measures were noticeably better than manual measurements.[19] When the manual drawing of lines is replaced by automated line drawing, Shea et al. reported that the Cobb angle can be accurately measured with decreased or at least equal intra-observer variability.[20]

Shea et al. demonstrated that when the manual drawing of lines is substituted by automated line drawing, the Cobb angle may be accurately determined with decreased or at least equivalent intra-observer variability.[21] The Cobb angle measurement was recently established by Allen et al., although manual identification of five separate anatomical landmarks between vertebrae T4 and L4 was still required.[22] A computerised version of the Greenspan index was proposed by Tang et al., who discovered a moderate connection (R = 0.41-0.92) between it and the Cobb angle. The evaluation of the Cobb angle is influenced by a number of factors that can increase the measurement variability (e.g., radiographic markers of wide diameter, selection of end vertebrae, bias of different observers, inaccurate protractors, image acquisition techniques, patient positioning, acquisition time, image size).[23]

The lumbosacral angle, which is a measurement of the angular position of the sacrum along a horizontal axis rather than of the actual amount of lordosis, was found to be a more accurate way to assess lordosis in a recent study by Okpala.[24]

One investigation compared the non-constrained Cobb technique (non-constrained limit vertebrae) to the constrained Cobb technique (constrained limit vertebrae), evaluating the reliability and therapeutic usefulness of each method. Using restricted and non-constrained Cobb approaches, three observers measured the lumbar lordosis (LL) twice. Excellent reproducibility is provided by the non-constrained Cobb technique used in computer-assisted analysis of the sagittal profile. The non-constrained Cobb technique considers the variability in the level of transition between the TK and LL as opposed to the constrained Cobb technique. Therefore, it is advised to use a computer-assisted method while employing the non-constrained Cobb methodology.[25]

One of the research used the Cobb measurement to assess the results for a number of pairs of data samples, and the findings "rejected the null hypothesis," showing that the three ranking data samples had a high level of correlation. The highly associated results indicated that the Cobb measurement obtained by the MBR technique, which focuses on computing the Cobb angle for spine curvature, might be used as a novel indicator for scoliosis severity diagnosis.[26]

The Cobb method was one of the earliest techniques for assessing sagittal spinal curvature, while being first created for the examination of spinal abnormalities in the coronal plane. “Modified Cobb method"[27], which makes use of vertebral endplate lines to create angles on sagittal radiographs, has been used to assess segmental angulation[28,29,30,31], thoracic kyphosis[32,33,34,35,36], lumbar lordosis[37,38], and cervical lordosis.[39,40] The stated limitations, which are largely centered around the fact that the Cobb angle primarily reflects endplate tilt and endplate architecture[41], are comparable to those present in measurements of coronal curvature and prevent the detection of changes in regional curvature. The Cobb angle may be the same for two spinal curvatures of different magnitudes as a result.[42] The Cobb method (or modified Cobb method), which measures angles on sagittal radiographs using vertebral endplate lines, is now considered the gold standard for determining the amount of lumbar lordosis. This technique is relatively easy to use and has a high level of reliability.[1] It has found to be a standard measurement technique (Cobb's method) to determine the distance between the superior endplates of the first sacral vertebra and the first lumbar vertebra.[7]

Clinical studies have been conducted to quantify the degree of scoliosis and evaluate intra- and interobserver variability using manual and computerised techniques. The outcome showed exceptional levels of agreement between measurements taken using the digital method, as well as performance that was comparable to that of the manual approach. Even so, there have been situations with both techniques where the difference between the two measures was higher than 10°. The usage of various vertebrae and image quality issues, which would have caused an incorrect labelling of the end plates, are believed to be some of the causes of these discrepancies. The results therefore showed that Cobb angle measurements could be repeated on a computer with the same level of precision as they could be performed in conditions similar to those found in clinical practise. When the Cobb method was employed to quantify the scoliotic curvature in the frontal plane, the computer-assisted method (digital method) was found to be clinically beneficial and appropriate. [43]

One such study compared two alternative techniques—the nonradiologic Spinal Mouse (SM) and the radiologic Harrison Posterior Tangent Method (HPTM)—to the Cobb angle for measuring lumbar lordosis. Correlations between HPTM, the Cobb angle, and SM were analysed using the Spearman rank correlation coefficient, and intraexaminer and interexaminer agreement were analysed for HPTM and the Cobb angle using intraclass correlation coefficients. The study's findings demonstrated that the HPTM had a stronger correlation with the Cobb angle than the SM did. The Cobb angle, based only on L1 and L5, revealed modest lordosis for one of the subjects, but the HPTM and intraexaminer and interexaminer agreement for both were excellent (all intraclass correlation coefficients > 0.90). However, a lot of doctors still use the Cobb angle since it is well known, but HPTM is less well known because it was first used as part of a secretive method in the chiropractic industry. Since more lines need to be drawn and more angles need to be measured than with the Cobb angle, the HPTM also takes longer to complete for each radiograph than the Cobb angle. [44]

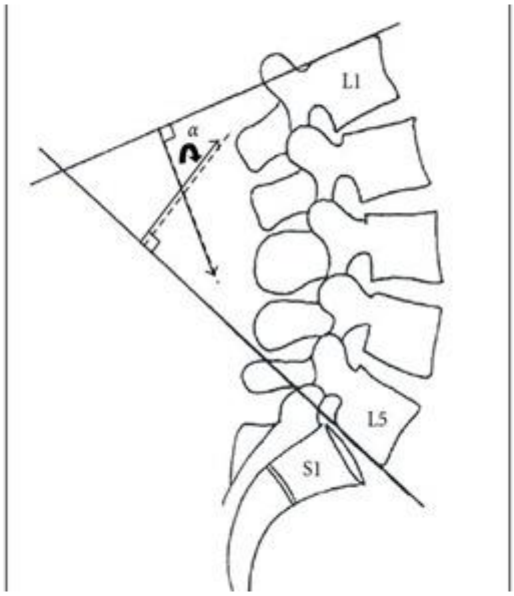

Fig No.1

Fig No.2

Following the meta-analysis, systematic searches were carried out, and 21 studies were incorporated into the qualitative analysis. The methods used to evaluate cervical spine position were summarised in this systematic review, together with data on their validity and reliability. This panorama made it easier to decide on a method for assessing the cervical spine in the sagittal plane using radiography or photogrammetry. Here, the meta-analysis revealed that the Gore angle (C2-C7), the absolute rotation angle, the Cobb method (inferior C2 - inferior C7), and the Cobb method (middle C1 - inferior C7) all have extremely high intra-rater reliability. The Cobb method (inferior C2 - inferior C7) also has extremely high inter-rater reliability. More specifically, The ICCs ranged from high to very high, and the I2 displayed high heterogeneity (> 50%) in the inter- and intra-rater analyses of the Cobb method (inferior C2 - inferior C7) for both absolute rotation angle and Gore angle. While the ICCs ranged from high to very high and the I2 showed low heterogeneity (0%) in the inter-rater analysis of the Cobb method (middle C1 to inferior C7).[45]

The most popular method for assessing thoracic kyphosis (TK) and lumbar lordosis (LL) using sagittal radiographs is the modified Cobb approach, which was inspired by the method initially created by Cobb[46] to measure the severity of scoliosis. The non-constrained Cobb methodology, which takes into account the variability in LL length, allows for thorough evaluation of the entire lordotic portions of the spine, although the use of constrained limit vertebrae (constrained Cobb technique) is the method that is most frequently used. Thus, the Cobb method has become the standard for measuring kyphotic and lordotic curvatures in sagittal radiographs.[47,48]

An investigation was conducted to analyse the thoracic kyphosis and lumbar lordosis reference values in order to learn more about the inter- and intrarater reliability of Cobb's angle. Cobb's angle approaches have proven reliable in the reliability tests' outcomes.[49]

According to a number of radiologists, the Cobb angle can be used to evaluate the initial curve, analyse the increasing amplitude of curves, and ascertain when a patient would most likely benefit from surgery. The accuracy of the Cobb angle measurement is significantly influenced by the radiologists' individual experiences.[50] Many clinicians employed this technique, and they presented the findings based on the measurement error. Some researchers claim that this inaccuracy can range up to 11.8. In the past, measurements were taken with the Cobbometer, but the error was so serious that it changed how scoliosis patients were identified and treated. In order to more properly assess the entire three-dimensional spinal deformity utilising state-of-the-art imaging diagnostic techniques that permit 3D reconstructions, new procedures for estimating the Cobb angle are being developed.[51] The Cobb method is used to manually identify the terminal vertebrae. However, because of its superior consistency, ease of use, and ability to identify larger angles for more severe spine curvatures, the Cobb method has generally been chosen.[52]

There was no statistically significant difference between the least variable measuring procedures for the L4-L5 and L5-S1 levels according to variance estimates between the Cobb technique and the posterior vertebral body technique. Direct comparison revealed that the manual and computer-assisted methods were statistically equivalent and had comparable levels of variance. Prior to surgery, following interbody fusion, and following motion-sparing disc arthroplasty, it was believed that the anterior vertebral technique, which did not show a significant difference from other techniques, would prove to be the most accurate way to measure segmental lumbar lordosis in patients.[53]

CONCLUSION:

Even though there are numerous manual and automated methods, many of them have proven to be too challenging and inconsistent for everyday clinical use. Additionally, numerous statistical measurements of a method's dependability and repeatability are used in different study, which usually makes it challenging to translate between different metrics and conduct additional comparisons of different studies. Surprisingly, when compared to other 2D methods, The Cobb approach was found to be the most reliable.

The results also suggested that the digital method is clinically beneficial and appropriate to assess spinal curvature in the frontal plane because Cobb angle measurements could be replicated in a computer as precisely as they could be with the traditional (manual) method under circumstances similar to those found in clinical practice. As a result, the Cobb method has been codified, and numerous studies have tested and verified its crucial component of "reproducibility."

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