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Detection of progressive idiopathic scoliosis during growth using back surface topography: A prospective study of 100 patients

Détection de l'évolution des scolioses idiopathiques en période de croissance par la topographie de surface du dos : étude prospective sur 100 patients

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Abstract

The progression of adolescent idiopathic scoliosis is typically monitored via regular radiographic follow-up. The Cobb angle (as measured on whole-spine radiographs) is considered as the gold standard in scoliosis monitoring.
Objective. – To determine the sensitivity and specificity of back surface topography parameters, with a view to detecting changes in the Cobb angle.
Patient and method. – One hundred patients (mean age: 13.3) with Cobb angles greater than 10 degrees were included. Topographic parameters were measured in a standard position and in a position with hunched shoulders. Gibbosities and spinal curvatures were evaluated.
Results. – An increase of more than 2 degrees in any one gibbosity or in the sum of the gibbosities (in either of the two examination positions) enabled the detection of a five-degree increase in the Cobb angle with a sensitivity of 86% and a specificity of 50%.
Conclusion. – If the present results are confirmed by other studies, analysis with back surface topography parameters may reduce the number of X-ray examinations required to detect increases in the Cobb angle.

Keywords: Surface topography; Spine; Scoliosis; Radioprotection

Résumé

L'évolution de la scoliose idiopathique de l'adolescent est classiquement contrôlée par un suivi radiographique régulier. L'angle de Cobb, mesuré sur des radiographies de rachis entier, est considéré comme le *gold standard* de ce suivi.
Objectif. – L'objectif de notre travail était d'étudier la sensibilité et la spécificité de paramètres de topographie de surface du dos pour détecter les changements de l'angle de Cobb.
Patients et méthode. – Cent patients âgés de 13,3 ans en moyenne et présentant des angles de Cobb de plus de 10 degrés ont été inclus. Les mesures des paramètres topographiques étaient réalisées dans une position standard et dans une position permettant de dégager les omoplates. Les paramètres topographiques testés étaient les gibbosités et les courbures rachidiennes.
Résultats. – La majoration de plus de 2 degrés de l'une des gibbosités ou de la somme des gibbosités mesurées dans l'une ou l'autre des positions permettait de détecter les aggravations de 5 degrés de l'angle de Cobb avec une sensibilité de 86 % et une spécificité égale à 50 %.
Conclusion. – Si ces résultats sont confirmés par d'autres études, l'analyse en topographie de surface pourrait réduire le nombre de radiographies utilisées pour détecter les majorations de l'angle de Cobb.

Mots clés : Topographie de surface ; Rachis ; Scoliose ; Radioprotection

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1. English version

1.1. Introduction

Adolescent idiopathic scoliosis corresponds to a three-dimensional deformation of the spine. The prevalence of this condition ranges from 0.5 to 4%, depending on the reference angles used [1]. In the absence of aetiological treatment, patient care relies on physical and surgical techniques [2]. Therapeutic decisions are based on clinical examinations and radiological assessments [3]. The rationale for this type of care is based on the ease of performance of X-rays and the high inter-reader reproducibility of this approach when performed under standardized conditions [4]. However, the X-ray-based approach repeatedly exposes the patient to ionizing radiation [5,6], which is responsible for an increased risk of carcinogenesis in patients being monitored for scoliosis/kyphosis [7,8].

In order to avoid unnecessary X-rays, clinical examinations (such as Adam's forward bend test) are used to screen for waist symmetry, shoulder balance spinal curves or gibbosities. Indeed, the forward bend is a simple, reproducible and sensitive test for the detection of scoliosis [9]. However, its value in the monitoring of scoliosis has not been extensively evaluated.

Non-radiological instrumental techniques have been developed with a view to detecting scoliosis and monitoring its progression. These approaches measure the back's surface topography and are mainly based on optical devices: the Optronic Torsograph [10], computer optical topography [11], raster stereography with the Quantec Spinal Image System [12,13], the Formetric system [14], the Inspeck system [15], the ISIS2 [16], and Fortin's system [17]. Additionally, laser doppler [18–23] and ultrasound [24] techniques have also been used to map the back surface. These devices have very satisfactory measurement reproducibilities in terms of both inter-reader agreement and repeated examinations [12,16,25,26]. In contrast, the lack of data on the optical devices' ability to detect changes in the Cobb angle [20,24,27,28] means that these systems are rarely used [29]. Hence, many X-ray examinations tend to be performed before the absence of progression can be confirmed.

This raises the question of whether it is possible to reduce the number of X-rays used to monitor idiopathic scoliosis during growth periods in older children and adolescents.

In this context, the objective of the present study was to evaluate the sensitivity and specificity of a number of optically measured topographic parameters for detecting the accentuation of progressive idiopathic scoliosis in pre- and peripubescent children, with a view to avoiding unnecessary follow-up X-rays in this population.

1.2. Patients and methods

1.2.1. Study design and procedures

We performed a prospective, non-interventional study that included all the children consulting a private-practice physical and rehabilitation medicine (PRM) physician for the treatment of idiopathic scoliosis of more than 10 degrees relative to the initial Cobb angle. The exclusion criteria were severe scoliosis requiring direct surgical treatment, patent congenital abnormalities on X-rays and neurological abnormalities. All patient inclusions and topographic measurements were performed by the same physician. In compliance with the Declaration of Helsinki, all the patients (together with their parents) were provided with comprehensive information and gave their consent to use of their personal data in the study. In all, 100 patients were consecutively included over a three-year period. The monitoring frequency was exactly the same as in standard care with individual adjustments.

The X-rays were performed without a corset. A topographic analysis of the surface of the back was performed in a consultation a few days after each radiological assessment. The radiological and topographic parameters were recorded at each step in the patient's follow-up.

1.2.2. Radiological parameters

Telemetry X-ray images of the spine were acquired on large cassettes (30–90 or 30–120). The Cobb angle was always calculated by the PRM physician supervising the scoliosis follow-up. It was defined as the angle formed between the upper and lower endplates of the upper and lower end vertebrae, defined as those with the greatest slope relative to the horizontal [30]. The spinal curves were topographically classified into three patterns [31]:

- type A = cervicothoracic and upper thoracic curves above a contralateral thoracic or thoracolumbar counter-curve;
- type B = thoracic and thoracic-lumbar curves above a lumbar counter-curve;
- type C = lumbar and thoracolumbar curves starting with an oblique iliolumbar segment and without a lower lumbar counter-curve.

We considered progressing curves to be those that worsened between two successive measurements of the Cobb angle. Three different progression thresholds were considered: 5 degrees (corresponding to the threshold most frequently used in the literature), 3 degrees (corresponding to the lower boundary of intra-observer variability in X-ray reading, as reported by Morrissy et al. [32]) and 10 degrees (a threshold used by other researchers [12]).

1.2.3. Parameters describing the back's three-dimensional topography

We used the BIOMOD^{TM}-L system (AXS MEDICAL, Merignac, France) to study the back's surface topography; the system's reproducibility has already been studied in young patients with scoliosis [33].

Before each topographic examination, the clinician placed four skin markers near the C7 spinous process, the fossae lumbales laterales and the top of the intergluteal cleft. Next, the physician determined the alignment of the spinous processes by palpation and drew a line with a marker.