

Literature review / Revue de la littérature

Does adolescent idiopathic scoliosis relate to vestibular disorders? A systematic review

*La scoliose idiopathique de l'adolescent est-elle liée à une dysfonction vestibulaire ?
Une revue systématique*

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Abstract

Adolescent idiopathic scoliosis (AIS) is a tridimensional deformity of the spinal column. This frequent disease, which has no clearly identified pathogenic mechanism, can have serious consequences. It has been hypothesized that unilateral and isolated vestibular disorders could be the origin of AIS. The objective of this work is to verify this hypothesis and to establish a pathophysiological model.

Method. – We performed a Pubmed-NCBI search, for the period 1966–2013, crossing the keyword scoliosis with the following keywords: vestibular, labyrinthine, postural control.

Results. – This search retrieved 66 articles. Twenty controlled studies were considered for study. Their analysis showed discordant results. This review cannot confirm a link between isolated vestibular disorder and occurrence of development of scoliosis.

Conclusions. – There is not enough evidence to show a link between unilateral, isolated, vestibular dysfunction and AIS. From these findings, we propose a more global pathophysiological concept, which involves a trouble of the orthostatic postural control, with disturbance in the multisensory integration of vestibular, visual and somesthetic inputs. AIS could be the consequence of a reorientation of the longitudinal body axis in accordance with an erroneous central representation of verticality. An assessment of the sense of verticality would allow evaluate this hypothesis.

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Keywords: Adolescent idiopathic scoliosis; Vestibular dysfunction; Physiopathology; Verticality

Résumé

La scoliose idiopathique de l'adolescent (SIA) est une déformation tridimensionnelle du rachis, fréquente, susceptible de conséquences graves, sans explication pathogénique claire. L'hypothèse d'une perturbation vestibulaire, unilatérale, isolée, à l'origine de la SIA a été proposée. L'objectif de ce travail est de vérifier cette hypothèse et d'en déduire un modèle physiopathologique.

Méthode. – Nous avons effectué une recherche sur Pubmed-NCBI, sur la période 1966–2013, en croisant le mot clé *scoliosis* avec les mots clés : *vestibular, labyrinthine, postural control*.

Résultats. – La recherche a permis de recueillir 66 articles. Vingt études contrôlées ont été retenues. Cette revue ne confirme pas de lien entre une atteinte vestibulaire unilatérale, isolée et l'apparition d'une scoliose.

Conclusions. – Les preuves ne sont pas suffisantes pour établir un lien entre une atteinte vestibulaire isolée et l'apparition d'une SIA. À partir de ces résultats, nous proposons un modèle physiopathologique plus global faisant intervenir un trouble du contrôle postural orthostatique par

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perturbation de l'intégration centrale multisensorielle des différentes informations vestibulaires, visuelles, et somesthésiques. La SIA pourrait être la conséquence d'une réorientation de l'axe corporel longitudinal sur une représentation centrale erronée de la verticale. Une évaluation du sens de la verticalité permettrait d'explorer cette hypothèse.

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Mots clés : Scoliose idiopathique de l'adolescent ; Dysfonction vestibulaire ; Physiopathologie ; Perception de la verticale

1. English version

1.1. Introduction

Adolescent idiopathic scoliosis (AIS) is a three-dimensional spinal deformity that affects 1–3% of the population aged 10–16 years. Female predominance is noted but no etiopathogenic mechanism has been identified. AIS is a progressive disease that can have serious consequences in adult life [1]. Most authors consider AIS to be multifactorial, involving genetic, tissular, hormonal, biomechanical and neurosensorial factors [1]. De Sèze et Cugy combine these factors into 4 distinct pathogenic categories [2]: asymmetric bone growth deregulation (autonomic nervous system dysregulation, asymmetrical activity of neurocentral cartilages); susceptibility of bones to deformation (hormonal and hematologic phenomena regulating bone metabolism); abnormal passive spine maintenance systems with an impact on the skeleton structure (intervertebral disc collagen, elastic fibres of vertebral ligaments); disturbance to the active spine maintenance systems which modify muscle tone applied to the musculoskeletal spine architecture [2]. Abnormalities of orthostatic postural control belong to this latter category [1,2]. Due to their role in orthostatic postural control, several authors have suggested an involvement of different sensory modalities in the genesis of scoliosis: the vestibular system [3,4], the visual system [5,6], and somesthesia [7,8].

Concerning the visual modality, several studies show a high incidence of scoliosis in the visually impaired population: Catanzariti et al. [5] found 5 times more incidents of scoliosis in these patients versus the control group; Grivas et al. [6] found 42% of scoliotic deformities in blind women. Oculomotor abnormalities are described in some patients with AIS: more than 50% have an abnormal optokinetic nystagmus [9], other work concludes with abnormal saccadic eye movements [10].

Some authors found poorer somatosensory performance in SIA: in Kessen et al. study [7], the patients with AIS and right hand dominant, have a proprioceptive deficit in the upper limbs (assessed by the precision positioning of the fingers). Another study shows an increase in vibration thresholds of metatarsophalangeal joints, in patients with AIS [8].

Assessments by brain imaging in the AIS show abnormalities of the structures involved in the orthostatic postural control. For example, some parts of the vestibular cortex (such as the lateral sulcus) have a lower cortical thickness in AIS patients [11], on the other hand, the cerebellum has a larger volume in scoliotic subjects [12].

Among the sensory factors which may participate in the formation of a structural scoliosis, the vestibular system is

certainly the most involved in studies [13–17]. An unilateral and isolated vestibular dysfunction, would, through the vestibulo-spinal pathway, give rise to an asymmetric paraspinal muscle tone, which, during spinal growth, could lead to scoliosis [3,4].

Our purpose was to determine whether data in the literature confirms this hypothesis proposition and, from the results of this review, to propose SIA pathophysiological model.

1.2. Methods

We performed a Pubmed-NCBI search, for the period 1966–2013, crossing the keyword “scoliosis” with the following keywords: “vestibular”, “labyrinthine”, and “postural control”. We distinguished clinical studies and experimental animal studies. We retained four types of studies:

- controlled experimental animal studies evaluating the effect of destroying the vestibular structures on spinal posture;
- controlled clinical studies comparing standard clinical vestibular tests in adolescents aged 10–18 years with and without AIS. Two categories of tests were considered depending on the vestibular subsystem studied: semi-circular canal (SCC) or otolith systems. For the SCC system, we retained studies on stimulation and/or measuring the vestibulo-ocular reflex (VOR). For the otolith system, we retained studies using otolithic stimulation tests and/or measuring the subjective visual vertical (SVV). To be retained for analysis, clinical studies had to use at least one of the above-mentioned tests;
- controlled studies (AIS versus controls, age 10–18 years) investigating the imaging of the vestibular system;
- controlled studies evaluating the incidence of AIS in a population defined by a vestibular disorder.

1.3. Results

The results were: “vestibular and scoliosis” = 44 articles; “labyrinthine and scoliosis” = 26 articles; “postural control and scoliosis” = 113 articles. After eliminating duplicates, reviews of the literature, non-controlled studies, general articles, and studies not corresponding to the four categories defined in the protocol, we selected 20 controlled studies investigating the vestibular system in AIS (Fig. 1):

- controlled experimental animal studies evaluating the effect of destroying the vestibular system on spinal posture (3 articles);
- controlled clinical studies in adolescents aged 10–18 years comparing standard clinical vestibular tests in groups with and without AIS (13 articles);

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