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Review Article

Prevalence and risk factors for neural axis anomalies in idiopathic scoliosis: a systematic review

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Abstract

BACKGROUND: There is ongoing controversy about the routine use of magnetic resonance imaging (MRI) preoperatively in patients with presumed idiopathic scoliosis (IS). Routine MRI can help identify possible causes for the deformity and detect anomalies that could complicate deformity surgery. However, routine MRI increases health-care costs significantly and may reveal mild variations from normal findings without clinical relevance, which can still lead to anxiety and influence decision-making.
PURPOSE: Given the necessity to make evidence-based decisions both in the light of quality of care and cost control, the aim of this review is to report the prevalence of neural axis anomalies in IS and to identify risk factors associated with these anomalies.
STUDY DESIGN: A systematic review was carried out.
METHODS: An electronic search of PubMed, Embase, Cochrane, and Cinahl until May 2017 was performed. Studies were assessed by two reviewers independently according to predetermined inclusion (MRI in presumed IS) and exclusion criteria (diagnosis other than IS).
RESULTS: Fifty-one studies were included comprising 8,622 patients. In 981 patients, anomalies were found, resulting in an overall prevalence of 11.4%. The prevalence was 10.5%, 9.0%, and 14.2% when screening was performed of all IS patients, preoperative patients, or patients with presumed risk factors. The prevalence of a syrinx (3.7%), an Arnold-Chiari malformation (3.0%), or a combination of both (2.5%) was highest. Less frequent diagnoses included tethered cord (0.6%), an incidental malignancy (0.3%), and split cord malformations (0.2%). Risk factors for intraspinal anomalies included early-onset scoliosis, male gender, atypical curves, thoracic kyphosis, and abnormal neurologic findings such as reflexes and sensation.
CONCLUSIONS: This systematic review shows that a significant number of patients have intraspinal anomalies on preoperative MRI in (presumed) IS. The prevalence of finding spinal axis abnormalities increases in preselected patient groups with specific risk factors.

Keywords: Chiari malformation; Idiopathic scoliosis; Magnetic resonance imaging; Neural axis anomalies; Prevalence; Risk factors; Syrinx

FDA device/drug status: Not applicable.

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Introduction

Although the term "idiopathic scoliosis" (IS) implies that its etiology is unknown, many concomitant neuro-axial abnormalities have been described that are either held responsible for causing the deformity, or may influence deformity surgery [1–7]. Therefore, routine magnetic resonance imaging (MRI) screening can be used to rule out these possible underlying causes and screen for neural axis anomalies in patients with presumed IS. These anomalies present a variety of therapeutic dilemmas. Some of these anomalies are suggested to require prior neurosurgical treatment before deformity surgery or lead to an increased risk of complications. As there is no consensus in neurosurgical literature on when to intervene for a neural axis lesion in neurologically intact patients, it may even lead to unnecessary neurosurgical interventions before deformity correction. Furthermore, these routine MRI scans can also reveal other unexpected but benign anomalies that are unlikely to cause problems, but are likely to cause anxiety or more medical testing. The unexpected findings with unclear clinical relevance may lead to fear or more tests that are often unnecessary. Consequently, the use of MRI to elucidate these abnormalities in the routine assessment of scoliosis patients is still debated.

Given the necessity to make evidence-based decisions both in the light of quality of care as well as cost control, we should know what actually is the prevalence of neural axis anomalies in AIS patients and if these are associated with risk factors. The aim of this systematic review study is to report the prevalence of neural axis anomalies in patients with presumed IS and to assess whether anomalies are associated with certain risk factors. A "PICOS" was formulated. We defined our population (P) as patients with presumed IS. The intervention (I) was presence of general, radiological, and neurologic risk factors for spinal axis anomalies during examination of the patient. We compared (C) this intervention with the absence of these risk factors, for the outcome (O) consisting of spinal axis anomalies on MRI of the entire spine. Study designs (S) consisted of all published literature.

Materials and methods

The systematic review was performed in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines [8]. Methods used for the analysis, search strategy, and inclusion criteria were specified in advance and were registered in the international register of systematic reviews (http://www.crd.york.ac.uk/PROSPERO, protocol number CRD42015030159).

Search strategy

An electronic search of the literature has been conducted up until May 2017, in the regular databases such as PubMed, Embase, Cochrane, and Cinahl, by using MeSH and EMBASE-terms, as well as free text words. The search terms included "scoliosis," "magnetic resonance imaging," or synonyms of these terms and are reported in Supplementary Table S1.

Study selection

Two reviewers independently assessed the literature. Inclusion criteria for this systematic review were studies describing patients diagnosed with presumed IS who had undergone MRI of the entire spine and reported data on the prevalence of neural axis anomalies or risk factors associated with them. Studies had to be written in English, Dutch, or German language and be available in full text format. Studies describing a population with congenital or neuromuscular scoliosis, or any scoliosis other than IS were excluded. Studies without original data and reviews were also excluded. The literature was first screened by title and abstract with subsequent examination of the full text articles to assess the relevance. In addition, bibliographies of all selected full text articles were reviewed to identify potential additional eligible articles.

Data extraction

Data extraction of the selected manuscripts was performed independently by the two reviewers. The original manuscripts were reviewed without blinding for authors and affiliation. Disagreements between reviewers were resolved by consensus after discussion. Data from included studies were extracted using a predeveloped data extraction form. The collected data consisted of study characteristics (eg, publication year, country of origin, study design, patient recruitment criteria, number of patients), neural axis anomalies, and the number of patients with and without neural axis anomalies for the reported risk factors in individual studies. As it may be a potential source of bias, the selection of the patient cohorts was reported for each individual study.

The presence of neural axis anomalies was first stratified by the described risk factors. Subsequently, a meta-analysis of the studies was performed using Review Manager 5.3. Risk ratios were calculated using Review Manager 5.3 to quantify how strongly the risk factors are associated with the presence of neural axis anomalies. Risk ratios (RRs) with 95 percent confidence intervals (95% CIs) were reported, and p-value of $<.05$ was considered statistically significant.

Results

Study selection and data extraction

The search resulted in 935 articles (Figure). After screening titles and abstracts, 124 full text articles were screened. Of these studies, 51 met our inclusion and exclusion criteria and were included in this review. Cross referencing did not result in additional studies. The 51 studies consisted of 24 prospective and 27 retrospective cohort studies (Table 1).

The prevalence of spinal axis anomalies and risk factors were extracted by two independent raters. The two