

## Review Article

# Minimally invasive surgery in the treatment of adolescent idiopathic scoliosis: A literature review and meta-analysis



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## ABSTRACT

**Background context:** Spinal fusion surgery for scoliosis can be performed using a traditional open approach, or by following a minimally invasive approach. Minimally invasive surgery (MIS) is associated with theoretical advantages, such as reduced blood loss and a shorter hospital stay, yet there is no consensus in the literature with regard to the best treatment approach for adolescent idiopathic scoliosis (AIS).

**Purpose:** To assess the clinical outcomes of patients with AIS treated with either an open or minimally invasive approach.

**Study design:** Systematic review and meta-analysis of English-language studies for the treatment of adolescent idiopathic scoliosis.

**Patient sample:** Pooled results from level 1 and 2 studies.

**Methods:** We carried out a systematic literature search of EMBASE and MEDLINE, identifying studies investigating MIS in the treatment of AIS. Percentages of curvature correction were pooled and analysed.

**Results:** The literature search returned 50 articles, of which we determined 4 studies to be relevant. The pooled percentage curve correction across these groups was 62.05% for the MIS group and 70% for the open surgery group. Although these data are significant ( $p = 0.001$ ), the available studies are of variable quality, and sample sizes small.

**Conclusions:** Patients with adolescent idiopathic scoliosis can be managed with either a traditional open approach or a minimally invasive approach. The data suggests that open surgery offers an advantage in terms of curve correction, compared to minimally invasive surgery, however more investigation (in the form of robust randomized control trials) is needed before conclusive clinical suggestions can be recommended.

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## 1. Introduction

Physicians may recommend minimally invasive surgery to their patients over open surgery based on the fact that it has a lower rate of wound infection,<sup>1</sup> reduced tissue damage, blood loss, length of hospital stay, and use of analgesics, along with an earlier resumption of activities of daily maintenance.<sup>2</sup> However at this time there is no clear consensus as to whether a minimally invasive approach is preferable to the open approach in terms of overall curve correction. Considering that there is also little evidence supporting the use of surgical techniques in the treatment of AIS when compared to less invasive techniques such as exercise or bracing,<sup>3</sup> these data call attention to the need for further research

in this field far more eloquently than they support a particular intervention.

When recommending interventions to their patients, physicians are not always guided by the best evidence, particularly when no such evidence exists; this phenomenon becomes especially clear when we consider the case of adolescent idiopathic scoliosis (AIS). A Cochrane review carried out in 2015 found that no conclusion could be drawn from the literature with regard to surgical versus non-surgical interventions in severe AIS; this study was an “empty review” which nonetheless highlighted the alarming dearth of research in this field.<sup>3</sup> Likewise, an earlier review found no evidence that the health-related aspects of AIS can be altered in any significant way by surgical intervention, concluding that there is no medical justification for an intervention which is associated with a high rate of complications.<sup>4</sup>

AIS does not inevitably end in disability. A prospective natural history study showed that untreated adolescent idiopathic

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scoliosis is not associated significantly with any physical impairment, other than shortness of breath and moderate back pain.<sup>5</sup> However, AIS is associated with an impairment of health-related quality of life, such as depression.<sup>6</sup>

Consideration should be given to both the physical and the psychosocial situation that arises due to the deformity, when discussing treatment options and morbidity, especially when the surgical aims for the correction of AIS are generally quite modest: the prevention of progression, or rendering the curve more “acceptable”. There is a lack of randomized control studies supporting the efficacy of either conservative or surgical treatments for AIS.<sup>7</sup> It is possible that the morbidity of the open surgical procedure outweighs the benefits of the intervention.<sup>8</sup> Can the same be said of the minimally invasive procedure? Is MIS an effective treatment for AIS when compared to open surgery?

### 1.1. Rationale and objectives

Given that minimally invasive spine surgery is becoming more common in the treatment of various spinal conditions, owing generally to the fact that a minimally invasive approach curtails iatrogenic trauma, we sought to determine whether those with AIS are better treated with MIS as compared to traditional open surgery, using curve correction (percentage) as a measure of efficacy. Additionally, we discuss the implications of our data of those found in the AIS literature at large.

## 2. Methods

We performed a PRISMA-compliant literature search using EMBASE and MEDLINE. The electronic databases were searched from January, 1980, through August, 2016, the rationale for these limits being that minimally invasive surgery has only generally been carried out on adolescents with AIS over the last couple of decades. We performed the searches in accordance with Medical Subject Headings. Search terms included were “scoliosis”, “adolescent idiopathic scoliosis,” “minimally invasive surgery,” “arthroscopy,” “arthroscopic,” “thorascopic,” and “MISS”. Both terms were searched as subject headings and keywords. Results that were not in English, those that contained adult patients, and those with no available abstract were strictly excluded. The inclusion criteria for our meta-analysis were as follows:

1. Prospective studies on subjects diagnosed with AIS that reported post-operative percentage of curvature correction.
2. Subjects were treated with MIS.
3. Studies had a minimum of 10 patients, and compared MIS group to a control that underwent open surgery.

These criteria were developed in line with the PICO guidelines for developing robust questions in evidence-based medicine.

### 2.1. Study selection

All articles underwent primary abstract review, after which a selection that met our predefined criteria, underwent full text review. We assessed the quality of the evidence offered in each study in accordance with the 2011 Oxford Centre for Evidence-Based Medicine Levels of Evidence.

### 2.2. Data collection, data items, summary measures, and synthesis of results

We extracted two metrics from each study, the mean correction percentage for MIS, and the mean correction percentage for traditional open surgery. The results of one study<sup>9</sup> were converted

to percentages in accordance with the procedure for calculating the correction rate put forth by Lee et al.,<sup>10</sup> however, this study was discarded at the full text screen because there was no control. We assessed statistical heterogeneity by carrying out a chi-squared test, in order to determine whether the any observed differences between the studies could be explained by recourse to chance alone. Effect size was calculated using Cohen’s *d*.

### 2.3. Risk of bias in individual studies

We assessed each study for risk of any bias that would result in heterogeneity of results, in accordance with the Cochrane Handbook.

### 2.4. Risk of bias across studies

We assessed the studies for publication bias, selection bias, performance bias, detection bias, and reporting bias.

## 3. Results

### 3.1. Study characteristics

The initial search resulted in 50 articles. After two-reviewer assessment, we identified 19 articles that met the inclusion criteria. Following a full text screen, 15 articles were excluded for a variety of reasons including poor study design,<sup>9</sup> insufficient cohort size<sup>11</sup> or because subjects were not limited to those with AIS (see Fig. 1). There were two prospective evaluations and two retrospective analyses. There were no randomized control trials. Descriptive information for each trial is given in Table 1.

Overall, 272 patients were treated for AIS, with 132 of those patients receiving MIS. All of the studies provided standard deviation and confidence intervals.

### 3.2. Summary of investigations

Faro et al. performed a prospective evaluation of pulmonary function in patients with AIS undergoing either an open or a

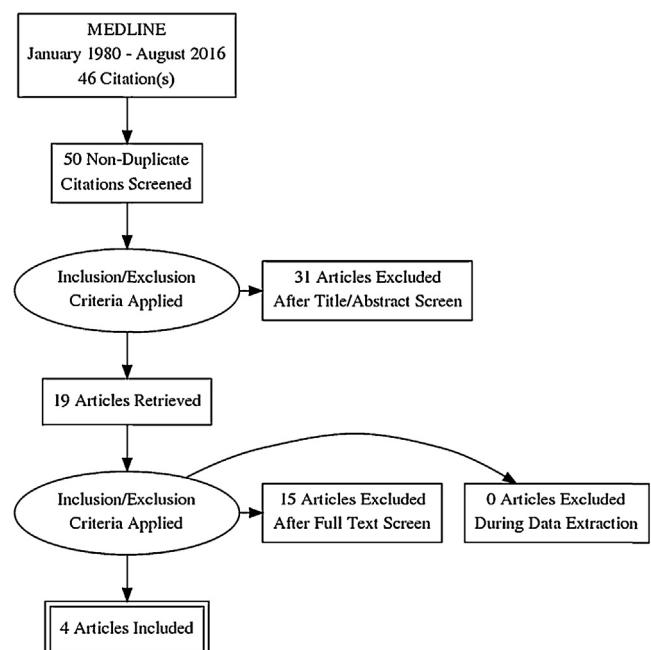


Fig. 1. Study selection process.

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