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The Use of Intraoperative Traction in Pediatric Scoliosis Surgery: A Systematic Review

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Abstract

Study Design: Systematic review.
Objective: To study the morbidity and the potential benefits of using intraoperative skeletal traction as an adjunct method for correcting scoliosis.
Summary of Background Data: Cotrel et al., used intraoperative skeletal traction in all patients in their original series of segmental spinal instrumentation for scoliosis correction (Cotrel et al., *Clin Orthop Relat Res* 1988;227:10–23). However, the use of intraoperative traction may introduce other forms of surgical morbidity, which has not been systematically studied.
Methods: Two independent reviewers searched MEDLINE (1948–current) and EMBASE (1980–current) using the keywords *scoliosis*, *intraoperative*, and *traction* in all fields, combined with *AND*. Studies were subject to full-text assessment against specific inclusion and exclusion criteria; discrepancies between the reviewers were resolved by a third independent reviewer. Data were extracted into standardized extraction tables and papers were critically appraised papers with regards to their relative strengths and weaknesses, with particular attention to the study objective.
Results: Nine papers were included: case report (n = 1), retrospective case series (n = 2), retrospective case–control (n = 6), and studies included both adolescent idiopathic scoliosis (AIS) and neuromuscular scoliosis. Seven studies reported positive effects of intraoperative skeletal traction on diverse outcome measures, such as correction of pelvic obliquity, Cobb angle, and axial plane deformity, as well as precluding the need for an anterior release preceding posterior instrumentation for large curves. Overall, there was only one reported postoperative traction-related complication (anterosuperior iliac spine pressure sore). One paper reported that intraoperative traction may evoke neuromonitoring signal changes in a large proportion of patients undergoing AIS surgery. These changes were responded to intraoperatively by decreasing or removing weight and none of the patients had postoperative neurologic deficits.
Conclusion: Isolated intraoperative skeletal traction may be a low-morbidity adjunct to facilitate scoliosis surgery. Further studies are needed to compare outcomes of scoliosis surgery with or without intraoperative skeletal traction.

Keywords: Scoliosis; Traction; Intraoperative; Adolescent idiopathic scoliosis; Neuromuscular scoliosis

Introduction

Axial traction has been used for centuries to treat spinal deformities [1]. This was based on the thought that prolonged traction exploits the viscoelastic properties of musculoskeletal tissues and yields greater deformity corrections when combined with other procedures [2]. Accordingly, traction has been used as a preoperative [3,4] or postoperative [5-7] treatment to augment corrections. The theoretical benefits of axial traction include minimizing corrective forces applied to spinal instrumentation in compromised bone [8,9], and it may correct spinal rotational malalignment before hardware placement. One of the main drawbacks to preoperative traction is the prolonged duration of traction (days to weeks). Additionally,

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pre- or postoperative traction may be associated with significant neurologic injury, as described in MacEwen et al.'s classic paper [10]. This is in contrast to Cotrel et al., original series on segmental spinal instrumentation for scoliosis correction, in which traction was used intraoperatively in all patients, and there were no described permanent neurologic injuries [11].

The research question of this systematic review was, In patients undergoing pediatric scoliosis surgery, does the use of intraoperative axial traction to facilitate deformity correction provide any intraoperative/postoperative benefit, and is it associated with significant risk to the patients? This is a timely review as the concept of optimizing anchor density in spinal instrumentation for scoliosis correction evolves [12]. Intraoperative traction may facilitate scoliosis correction by using low-density instrumentation as suggested in Cotrel et al., original series [2,11]. Furthermore, intraoperative traction may help manage large curves, which have been associated with increased health resource utilization and morbidity [13].

Materials and Methods

Two independent reviewers (JL and SA) used OvidSP to search EMBASE (1980–current) and MEDLINE (1948–current) for papers. A multifield search with the keywords *scoliosis*, *intraoperative*, and *traction* in "all fields," combined with *AND* was performed. Relevant journals were hand-searched (*Spine*, *Spine Deformity*, *Journal of Pediatric Orthopaedics*, *European Journal of Spine*, *Clinical Orthopaedics and Related Research*, *Journal of Bone and Joint Surgery [Am]*, and the *Bone and Joint Journal*). Duplicate papers were excluded. All abstracts returned with the initial search were scrutinized against specific inclusion and exclusion criteria (Table 1). Where there was discrepancy between the two reviewers, a third reviewer resolved the discrepancy (FFB). All papers satisfying the inclusion criteria were reviewed in full and the reference list in each paper was scrutinized for relevant papers (snowballing). Data were extracted into a standardized assessment form, including the following parameters: citation, study design, sample size, patient population, traction intervention, indication for traction, surgical approach, outcomes, complications, and comments. Conclusions were drawn based on a cumulative assessment of the positives and negatives of each study.

Table 1
Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
All study designs	Preoperative traction
All etiologies of pediatric scoliosis	No patient outcomes reported
All surgical approaches	Review papers
All languages	Letters to the editor
All methods of traction	Adult scoliosis

Results

The MEDLINE search yielded 34 abstracts, and the EMBASE search yielded 28 abstracts (Fig.). Eight studies satisfied the inclusion criteria and were selected for full-text analysis. One additional study was found by hand-searching the relevant journals or snowballing. All studies were retrospective, and the largest sample size was 5,114 (Table 2). Overall, 150 adolescent idiopathic scoliosis (AIS) patients and 106 neuromuscular (NM) patients were included in this review. Intraoperative traction was used to help correct Cobb angles [14-17], pelvic obliquity [8,16,18,19], or apical vertebral rotation (AVR) [17]. One study examined the influence of traction on blood loss and operative time [20].

Patient population

Three studies investigated the influence of intraoperative traction in patients with AIS [9,14,15], four studies included patients with NM scoliosis [8,16,18,19], and one study included both AIS and NM patients [17]. All AIS patients were treated with a posterior only approach [9,14,15,17], whereas NM were treated with a circumferential surgical approach [8], circumferential or posterior approach [18,19], or posterior approach [16,17].

Intraoperative skeletal traction intervention

One study used head-halter and skin traction [14] and the remainder used percutaneous skeletal traction with a distal femoral traction pin and a halo [8,9,16,18,19], or Gardner-Wells skull tongs [15,17,20] (Table 3). The weight used in all traction protocols was variable, with a maximal amount being 25% of body weight through the skull (maximum of 12 kg [9]), and 50% of body weight distally (maximum of 65 lb distally [15,17]). Two studies reported the size of traction pins used [15,19].

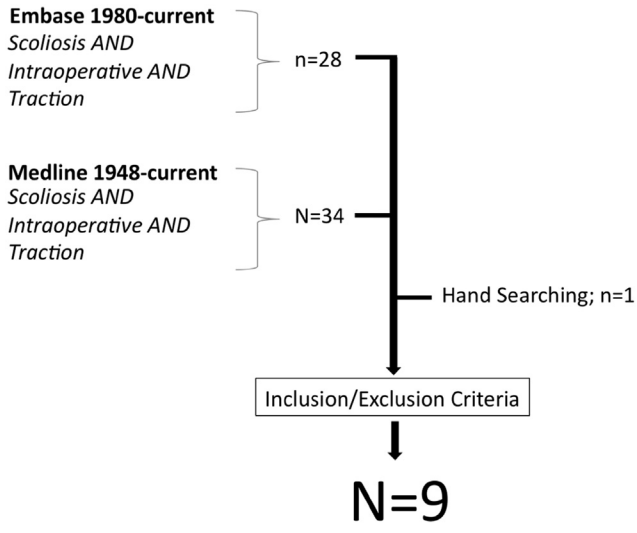

Fig. Search Strategy and Results