



Factors Leading to Persistent Postsurgical Pain in Adolescents Undergoing Spinal Fusion: An Integrative Literature Review



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ARTICLE INFO

Article history:

Received 20 December 2016

Revised 21 October 2017

Accepted 22 October 2017

Available online xxx

Keywords:

Pediatric

Pain

Adolescent idiopathic scoliosis

Spinal fusion

Integrative review

Pain management

ABSTRACT

Problem: Adolescent idiopathic scoliosis (AIS) is the most common spinal deformity among children and adolescents and the most frequent reason for corrective spinal fusion (SF). Of the children and adolescents who undergo SF, a significant number will experience persistent postoperative pain (PPP). This integrative literature review was conducted to identify and synthesize perioperative factors that may contribute to risk of developing PPP.

Eligibility Criteria: Articles which addressed PPP within the last 10 years and primary research on postoperative pain outcomes in adolescents after SF were selected for review.

Sample: 15 articles which met eligibility criteria were included.

Results: Preoperative pain intensity was the most significant factor identified in the development of PPP and increased postoperative pain. Social function and psychological factors also have role in the development of PPP. There were no theoretical models or frameworks for evaluating PPP incidence in adolescent with AIS after SF.

Conclusions: Perioperative factors such as, preoperative pain, correction magnitude, pain coping, anxiety and social functioning are vital to understanding a child's risk of PPP following SF. There is a need for theoretically-based studies to assess PPP among children and adolescents with AIS after SF surgery.

Implications: The Biobehavioral Pain Network (BPN) model was proposed, to encompass biological, social and psychological domains which may be responsible for incidence of PPP in children undergoing SF. Such a model can be used to systematically develop and evaluate personalized postoperative pain management strategies for this patient population.

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Problem

Each year, more than 2.4 million U.S. children and adolescents undergo surgical procedures, placing them at risk for developing persistent post-surgical pain (PPP), defined as pain in the location of the surgery that lasts ≥ 8 weeks (Katz & Seltzer, 2009; Kehlet, Jensen, & Woolf, 2006). Several studies examining the prevalence of PPP in adults have been conducted, though conflicting results remain. Prevalence of PPP in adults varies widely and can range from 10 to 65% depending on the type of surgical procedure (Batoz, Semjen, Bordes-Demolis, Bernard, & Nouette-Gaulain, 2016; Niraj & Rowbotham, 2011). Specifically, the prevalence of pediatric PPP is poorly documented. Some studies suggest that 15% of children will experience PPP, though of these

children, up to 30% of children report inference and burden of pain in their everyday activities (Fortier, Chou, Maurer, & Kain, 2011; Sieberg et al., 2013). Variation in the definition of PPP in regard to pain intensity and interference make it difficult to accurately predict its prevalence. Thus, making it difficult to fully estimate the burden of chronic pain on pediatric patients and its overall prevalence. Given the number of children and adolescents who are at risk of PPP, it is critical to examine predisposing factors so that healthcare providers have adequate knowledge to effectively assess and develop interventions to prevent or reduce PPP in this vulnerable population (Sieberg et al., 2013). A deeper knowledge of the predisposing factors of PPP could help to identify patients at risk, guide the development of targeted interventions and help to reduce the burdensome effects on quality of life. Each of these challenges has the potential for deleterious effects on a child's development and overall quality of life.

In particular, children and adolescents undergoing spinal fusion (SF) for adolescent idiopathic scoliosis are at increased risk of PPP due to the extent of surgery. Adolescent Idiopathic Scoliosis (AIS) is the most commonly diagnosed structural deformity of the spine in this age group

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(National Institute of Health, 2014). This abnormal curvature of the spine is generally found between the ages of 10 and 18, the typical age of skeletal maturity (Kepler, Meredith, Green, & Widmann, 2012). Children who are diagnosed with adolescent idiopathic scoliosis (AIS) have an increased risk of exposure to painful procedures, including diagnostic tests and treatment. Initial management of AIS includes non-surgical interventions, such as spinal stabilization braces, but corrective surgical procedures may be necessary to support maintenance or improvement of functional outcomes, and to decrease the risk of progressive neurological impairment as severity of the spinal curvature increases. To surgically correct AIS curvature and prevent or reduce further deformity, a SF is typically performed. SF requires extensive spinal manipulation and muscle separation, resulting in moderate to severe levels of postoperative pain (Basques, Bohl, Golinvaux, Smith, & Grauer, 2015; Connelly et al., 2014; Twycross, Williams, & Finley, 2015).

Recovery from musculoskeletal surgery such as SF, involves teaching patients and families about how to manage post-operative symptoms, monitoring progress of wound healing, functional outcomes, and adherence with rehabilitation exercises. PPP can interfere with progression of postoperative milestones, reintegration into school and social activities. Children experiencing persistent pain face several unique challenges, with up to 40% of children reporting that PPP interferes with their school attendance, participation in hobbies, maintenance of social contacts, appetite and sleep, and increases utilization of health services (Goodman & McGrath, 1991; Roth-Isigkeit, Thyen, Stöven, Schwarzenberger, & Schmucker, 2005; Walker, 2015). If nurses could predict which children were at risk for PPP, support services could be targeted toward more intensive case-management and/or follow-up. In an effort to deepen understanding on the current state of the science regarding prediction of PPP in patients undergoing SF surgery, we performed a literature review of articles published within the last 10 years. The purpose of the integrative literature review was to evaluate and synthesize research findings from studies focused on identifying factors that increase the risk of PPP as well as theoretical models and measures to evaluate PPP in adolescents with AIS after SF surgery. The following question guided the integrative literature review: *What factors have been shown to predict the severity and interference of postoperative pain after SF surgery for AIS in children and adolescents?*

Methods

The integrative literature review was guided by the methodology posited by Whittemore and Knafel (2006). A literature search was performed using the databases *PubMed/Medline*, *PsychInfo* and *CINAHL* to identify primary research articles that focused on identifying predisposing factors of PPP in children and adolescents undergoing SF surgery for AIS. Terms used to ensure data saturation included, “adolescent idiopathic scoliosis,” “postoperative pain,” and “spinal fusion.” Inclusion criteria for the integrative literature review included: (1) published in English within the last ten years (2006–2016), and (2) articles reported original research on postoperative pain outcomes among adolescents after SF. This period was selected as there have been significant advancements since 2006 in the surgical procedures and knowledge regarding the influence of biological and environmental factors on PPP. Exclusion criteria included surgical pain other than SF surgery, manuscripts discussing adult populations, review articles and publications reporting case studies. The process used to screen and select articles for the integrative literature review are shown in Fig. 1. This figure was informed by the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009). A total of 15 articles were included in the integrative literature review. Articles were excluded according to Meline's (2006) inclusion and exclusion criteria for systematic review.

Results

Of the 15 articles included within this integrative review, nine were conducted within the United States (Table 1). The remaining articles were conducted within the following countries: Canada (Ferland et al., 2016), Iran (Ghandehari et al., 2015), Italy (Mariconda, Andolfi, Cerbasi, & Servodidio, 2016), Brazil (Rodrigues, Saleme, Junior, Cardoso, & Junior, 2015), Sweden (Rullander, Lundstrom, Lindkvist, Hafflof, & Lindh, 2016), and Japan (Watanabe, Hasegawa, Hirano, Uciyama, & Endo, 2007).

Most of the studies included in the integrative literature review used the Scoliosis Research Society-22 instrument to examine scoliosis-specific health related quality of life including pain, activity, appearance, mental health and satisfaction (Bastrom, Marks, Yaszay, & Newton, 2013; Carreon et al., 2010; Landman et al., 2011; Spayner et al., 2015), the SRS-23 (Mariconda et al., 2016), the SRS-24 (Tsutsui et al., 2009; Upasani et al., 2008; Watanabe et al., 2007) or SRS-30 (Ghandehari et al., 2015; Sanders et al., 2010; Sieberg et al., 2013). The remaining studies used a visual analogue scale (Connelly et al., 2014; Rullander et al., 2016); the State Trait Anxiety Inventory-Child and number scale (Ferland et al., 2016); Spinal Appearance Questionnaire (Landman et al., 2011); SF-12 (Spayner et al., 2015); SF-36 (Mariconda et al., 2016; Rodrigues et al., 2015); or Trauma Symptom Checklist in Children and Youth Self Report (Rullander et al., 2016).

Several concepts were identified within the literature, many of which have an impact on the postoperative outcomes of AIS. These concepts range from predisposing factors, relating to an individual's personal, social and cultural backgrounds as well as perioperative interventions, care and education. Table 1 outlines the selected articles and their significant findings.

One of the most significant predisposing factors for PPP and postoperative pain outcomes, identified by several studies, was preoperative pain severity (Carreon et al., 2010; Connelly et al., 2014; Ferland et al., 2016; Rullander et al., 2016). Patients who reported persistent pain at 6 months to 24 months postoperatively had significantly increased pain scores at their preoperative appointments compared to patients who did not report PPP (Bastrom et al., 2013).

Several articles assessed relationships among the curvature angle of the spine before and after the surgical procedure and the frequency of PPP. Identified classification systems for spinal curvature across studies include the Lenke, Cobb and King Classification Systems (Connelly et al., 2014; Ghandehari et al., 2015; Landman et al., 2011; Sanders et al., 2010; Upasani et al., 2008; Watanabe et al., 2007). An association between PPP and the type or degree of curve correction was reported (Sanders et al., 2010; Watanabe et al., 2007). Sanders et al. (2010) found that participants with more pronounced preoperative Lenke curvature had more severe postoperative pain than other curvature types. Upasani et al. (2008) found adolescents to have worsened pain at 5-year follow-up, with a correlation between magnitude of the deformity and increasing postoperative pain scores. Whereas Watanabe et al. (2007) reported that pain correlated with the magnitude of the correction angle, as opposed to the preoperative curvature itself.

Though indirect, and less correlative than preoperative pain, social functioning and psychological factors have a role in the development of PPP. Of note, preoperative psychosocial factors such as anger, social and attention problems significantly contributed to an individual's postoperative pain levels (Rullander et al., 2016). In addition, children and adolescents who had effective pain coping strategies prior to surgery had a more rapid return to baseline (i.e. preoperative) pain levels and experienced greater functional recovery better during the inpatient stay (Connelly et al., 2014).

A secondary outcome of the review was an evaluation of theoretical models to evaluate PPP in adolescents with AIS after SF surgery. None of the cited articles within the literature review used a theoretical framework to holistically evaluate the predisposing factors of PPP after SF.

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