Perioperative Pain Management in Pediatric Spine Surgery

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KEYWORDS

• Scoliosis • Pain management • Pediatric • Patient-controlled analgesia • Epidural

KEY POINTS

- Adequate pain control improves patient satisfaction and decreases hospital length of stay.
- Multimodal pain control helps provide adequate analgesia while minimizing adverse effects.
- Postoperative protocols, including pain management protocols, are important tools to help prepare nursing and other support staff to provide efficient and consistent care.

INTRODUCTION

Pain management after spinal deformity correction surgery for scoliosis in the pediatric population can be difficult due to the magnitude of the procedure. Deformity correction with posterior spinal fusion, with or without anterior procedures, causes significant tissue trauma that can result in debilitating pain. Historically, pain control has been achieved with intravenous (IV) opiates through patient-controlled anesthesia (PCA) or through IV push methods administered by nursing staff. Opiates provide excellent analgesic effect; however, the consequences of using opiates alone may include inadequate analgesia, nausea, vomiting, constipation, urinary retention, somnolence, respiratory depression, and possibly longer hospital stays, or even opiate dependence. In adult total joint arthroplasty, multimodal pain control has become an increasingly common method to achieve pain control without these sequelae. Recently, the same techniques have been studied in pediatric spinal deformity correction surgery as well. The purpose of this article is to outline the state of pain management in pediatric spine patients, including the use of multimodal management and to evaluate where further advances can be made.

OPIATES

Opiates are the mainstay of treatment for postoperative pain in many pediatric procedures, especially those in which the patient or surgeon expects significant postoperative pain. Opiates act on receptors in the brain, spinal cord, and peripheral tissues. There are several types of opiate-based pain medications that vary in their potency and duration of action. Opiates can be given in multiple different modalities including, but not limited to, orally, intravenously, by a patient-controlled anesthesia (PCA) device, an epidural injection, or intrathecal administration. Most patients are treated in the immediate postoperative period with IV or PCA methods and transitioned to oral-based intake, but adverse effects may limit the dose of opiates a patient can receive. Opiate administration also may prolong hospital stay if adverse effects require treatment or if the patient is unable to mobilize and participate in physical therapy. Despite this, opiates remain an effective analgesic, and they are used as the mainstay of treatment because of their potent analgesic properties. Tolerance to

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opiates can develop relatively quickly, with some medications more likely than others to cause this.

Acute opiate tolerance has been reported with the use of the medication remifentanil. Remifentanil is an opiate frequently used by anesthesia providers during spinal deformity surgery because of its potency, short duration of action, and lack of interference with neuromonitoring; however, it has been shown to cause acute opioid tolerance, leading to 30% higher opiate requirements in the postoperative period.[1] It is believed that opiate-related adverse events may be related to the total dose given. Minor adverse events, including vomiting, pruritus, and constipation, are common and occur in approximately 40%, 20% to 60%, and 15% to 90% of patients, respectively.[2] More severe adverse events such as respiratory depression occur much less frequently; in 1 review, the rate of respiratory depression was identified as 0.0013%.[2]

NONSTEROIDAL ANTI-INFLAMMATORY DRUGS

Nonsteroidal anti-inflammatory drugs (NSAIDs) are a group of medications whose primary mechanism of action is inhibition of the enzyme cyclooxygenase (COX). This leads to a decrease in the production of prostaglandins, which are involved in the inflammatory response. NSAIDs have been demonstrated to provide good analgesia while decreasing postoperative opiate use after posterior spinal fusion in pediatric scoliosis surgery.[3] This may lead to a decrease in opiate-related adverse effects. It has been shown that NSAIDs decrease the number of hospital days patients require PCA use and also decrease the likelihood of prolonged hospital length of stay, defined as 4 days or more in a scoliosis database review by Rosenberg.[4] The concern with the use of NSAIDs is that they have gastrointestinal (GI) and renal adverse effects and have been linked to delayed bone healing in animal models.[5] This has been corroborated in certain adult populations.[6] Sucato and colleagues[7] compared patients who received ketorolac and those who did not after posterior spinal fusion for adolescent idiopathic scoliosis. An overall pseudarthrosis rate of 2.5% was found, but ketorolac did not increase the likelihood of pseudarthrosis. There is also a concern about the effects of NSAIDs on platelet function by inhibiting formation of thromboxane A2; however, bleeding-related adverse events such as increased likelihood of transfusion or increased reoperation rates have not been associated with the use of ketorolac when given in the postoperative period.[8]

OTHER ANALGESICS

Acetaminophen

Acetaminophen is widely used for pain management, either alone or compounded with other medications such as opiates. Acetaminophen is commonly administered by mouth, intravenously, or rectally. IV acetaminophen has been shown to decrease visual analogue scale (VAS) pain scores in the first 24 hours after surgery for scoliosis; however, it has not been shown to decrease opiate requirements, and no patients in the study by Hiller and colleagues[9] reached toxic levels of acetaminophen. Caution must be used with acetaminophen whether orally or intravenously, because many commonly used oral pain medications are compounded with acetaminophen; the surgeon must be aware of total daily acetaminophen intake to avoid toxicity. The recommended maximal daily dose of acetaminophen in children is 75 mg/kg/d with hepatotoxicity occurring at 150 mg/kg/d. If dosages remain below toxic levels, acetaminophen has been shown to have an excellent adverse effect profile and is safe to use in this population.

Gabapentin

Gabapentin was synthesized to mimic the hormone gamma-aminobutyric acid (GABA), an inhibitory neurotransmitter in the central nervous system. It has been found to be useful in several medical conditions including epilepsy and migraines, as well as for pain control. Gabapentin has been shown to improve pain scores and decrease opiate consumption after total knee arthroplasty, hysterectomy, mastectomy, and certain adult spine surgeries.[10] It is thought that soft-tissue trauma may sensitize the sensory nerves, making them hyperexcitable postoperatively, and gabapentin may exert its effect by decreasing spontaneous sensory nerve firing. Gabapentin has been used in adolescent idiopathic scoliosis, and when given as a single dose of 600 mg preoperatively, leads to mixed results. Mayell and colleagues[10] randomized 35 patients into a group given a placebo and a group given 600 mg of gabapentin 1 hour before surgery. Although the patients who were given gabapentin required less morphine postoperatively, the results were not significantly different. However, when gabapentin is given preoperatively at a dose of 15 mg/kg and continued into the postoperative period at a dose of 5 mg/kg 3 times daily, it has been demonstrated to decrease opiate use on