

Reinventing the wheel in scoliosis surgery: effective strategies for safely improving efficiency

Jonathan Bourget-Murray, MD CM
Fabio Ferri-de-Barros, MD, MSc

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Correspondance to:

F Ferri-de-Barros
Department of Surgery
University of Calgary
2500 University Dr. NW
Calgary AB T2N 1N4
ferriidb@ucalgary.ca

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SUMMARY

Posterior spinal instrumentation and fusion (PSIF) has been the standard operative treatment for adolescent idiopathic scoliosis (AIS) and is one of the most frequently performed elective pediatric surgeries in North America, incurring an expenditure of more than \$1.1 billion annually in the United States alone. This commentary reflects on the outcomes of systematically implementing intraoperative skull femoral traction (IOSFT) combined with navigated sequential drilling (NSD) during PSIF for AIS as strategies for quality improvement at our tertiary children's hospital.

As interest in technological advancements continues to grow, the surgical treatment of adolescent idiopathic scoliosis (AIS) is constantly evolving. Some innovations are implemented at a hefty cost, thus raising questions regarding added value of care. In fact, costs associated with the surgical treatment of AIS have recently been estimated to be more than \$1.1 billion annually in the United States alone.¹ The main drivers of costs are associated with the implants used to achieve deformity correction and the time-consuming nature of the surgery.²

This commentary discusses 2 surgical strategies, intraoperative skull femoral traction (IOSFT) and navigated sequential drilling (NSD), which have been systematically implemented at our academic children's hospital with the aim of safely improving efficiency in scoliosis surgery. Both techniques are modifications of previously described surgical techniques using current technology to improve procedural safety as compared with the original descriptions.

Intraoperative skull femoral traction

The IOSFT strategy was first described by Cotrel and colleagues.³ The pediatric spine surgery team at our institution introduced the systematic use of IOSFT for posterior spinal instrumentation and fusion (PSIF) in 2010. Our technique, compared with the original description, is used in conjunction with real-time neurophysiological monitoring. The benefit of this is twofold. First, IOSFT safely straightens the spine before definitive deformity correction. In fact, IOSFT has been shown to reduce scoliosis by 30%–50% before instrumentation.⁴ Second, neurophysiological monitoring informs the surgeons of impending intraoperative neurologic injury. The systematic implementation of IOSFT has led us to reduce our average operating time by more than 1 hour and altogether reduced our cost per case by \$3972. In addition, we found that traction protected against requiring blood transfusions, with an absolute risk reduction of 31% and a number needed to treat of 3.⁵

Navigated sequential drilling

In 2013, we piloted in a laboratory and introduced the routine use of NSD for preparing pilot holes for pedicle screw instrumentation. This technique is

a modification of the original technique by Roy-Camille and colleagues.⁶ With NSD, all pedicle pilot holes are drilled sequentially using a slow-speed oscillating battery-powered drill and 3.2 mm drill bit with a safety stop at 25 mm. With this strategy, we have safely improved surgical efficiency and significantly reduced the need for blood transfusion. The NSD technique creates smaller pilot holes than the conventional awl technique, therefore reducing bleeding. Because there is less bleeding, we can sequentially drill all pilot holes before pedicle screw instrumentation, thereby safely accelerating the pace of this surgical step. Accordingly, our blood transfusion requirements, including the use of cell saver, dropped from 33% to nearly zero. This is in contrast with the transfusion rates of 24%⁷ and 67.6%⁸ previously reported from 2 large American studies. For more than 5 years now, we have used NSD in combination with IOSFT during all our scoliosis surgeries.

Development

Our team has recently performed a retrospective quality-improvement study of 125 patients who underwent single-stage PSIF for AIS between January 2008 and December 2015 at our institution.⁹

Three cohorts were defined based on the intraoperative surgical strategies used. Twenty-eight patients underwent PSIF without either IOSFT or NSD, while 45 patients underwent PSIF with IOSFT alone. All these patients had their pedicle pilot holes prepared with a navigated awl. A third cohort of 52 patients underwent PSIF using both IOSFT and NSD. The primary outcome measures were classified by reportable indicators according to our regional health care system quality framework: median operative time, prevalence of cases requiring extended operating room time (finishing after 15:45 h), need for blood transfusion (cell saver or allogenic) and total cost per case.

Our findings suggest that the systematic use of IOSFT and NSD improved safety, efficiency and value-of-care in PSIF for AIS. Combined, IOSFT and NSD have reduced operating times by 59%, decreased the need for blood transfusions from 64% to 1.9% and reduced median cost per case by \$8500 (24%) from cohort A to cohort C.

The efficiencies facilitated by using IOSFT and NSD systematically have had other important ramifications at our institution. In our setting, shorter operating time increases the value of care by reducing cost and improving access to health care. With improved efficiency, we have been able to accommodate larger volumes of pediatric spine surgeries during normal operating days. Shorter operating times have allowed for improved utilization of operating room resources, ultimately resulting in shorter wait times for patients and reduced length of hospital stay. During the same time frame (2010–2015), an independent

audit of surgical site spinal infections at our institution showed a relatively lower incidence of infections than reported in the current literature.⁵

CONCLUSION

The combination of IOSFT and NSD for AIS surgery has, to our knowledge, never been reported, and its external validity has yet to be evaluated. If reproducible, the use of IOSFT and NSD during surgical treatment of scoliosis could have significant implications for health resource utilization across health care systems. We understand that the quality improvements reported here reflect the experience of 2 surgeons and their trainees in a single high-volume tertiary pediatric health care setting and thus may not be generalizable. However, this is a hypothesis-generating commentary, which invites further prospective investigation accounting for other plausible confounding variables. Such prospective study would represent an ethical challenge in our institution, given the overall quality improvements with the implemented strategies. We have taken the first step by studying NSD in a simulation laboratory, and our pilot data support our clinical findings.⁵

Affiliations: From the Cumming School of Medicine, University of Calgary, Calgary, Alta; and the Department of Surgery, Division of Pediatric Orthopedic Surgery, Alberta Children's Hospital, Calgary, Alta.

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