

Perspective Article

Surgical Complications of Idiopathic Scoliosis: Current Perspectives

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Abstract

Despite the good results, however, spinal surgeries for Idiopathic Scoliosis is associated with compromises. Neurologic injury is the most severe complication and is, all things considered, the most dreaded since it can occur at either the intra-or post-operative stage. Additional complications include dural tears and ophthalmologic or fringe neuropathy, which can be caused by persistent positioning. All spine surgeons must be entirely familiar with all likely developments of complications, as well as proper control.

Keywords: Complications; Fusion; Idiopathic; Scoliosis; Spine

Introduction

Idiopathic Scoliosis (IS) is the most recognized type of basic coronal spine deformity in kids, youths, and young adults with a general pervasiveness of 0.47% to 5.2% [1] Al-Mohrej et al. showed an increase in the yearly rate over 14 years from 5.1 to 9.8, an average of 4.6% per year [2]. Once skeletons have developed, any critical, idiopathic scoliosis will, in general, advance in many cases, causing issues. More specifically, the problems include body image, back pain, and pulmonary dysfunction in the later stages [1]. While most authors would admit that curves estimating $< 40^\circ$ to 45° in skeletally mature patients can be observed, however, surgical intervention is encouraged for spinal curves over 40° , before skeletal maturation [1]. The surgery aims to reduce the chances of additional growth of the curve by obtaining a stable skeletal arthrodesis to address the deformity. Scoliosis surgery operation is directed for grown-up patients who experience deformities as well as pain that are difficult to manage by entirely basing on non-operative treatment modalities. The implications are not always obviously represented. Some of the additional signs include rapidly growing curves in skeletally immature patients, progressive dual curves, curves producing notable trunk asymmetry, and curves that result in psychological discomfort due to cosmetic appearance [1].

With the tremendous increase in the cases, the recorded surgeries have also been rising over the past 15 years. For instance, in 1997, there were 1783 cases, which increased by 193% to 5228 surgeries in 2012 [3]. Nevertheless, the three most common surgical approaches so far are posterior fusion applied to 75% of the patients, anterior surgery with 18%, and finally combined fusion being at only 7% [4]. Though the prominent question is whether

or not the surgeries are successful without any complications. With the technological advancements, modern medical equipment and instruments, new surgical procedures, and new technology result in a reliable operational result. Unfortunately, cases of complications, as discussed previously, are usually reported. Moreover, the rate of complications among patients ranges at a consistent scale. For instance, after surgery, 5% to 25% of the patient had complications [3,5-7] Coe et al. record a 5.7% rate of complications regarding spinal fusion surgeries conducted in 6,334 IS victims [8]. The report shows that the anterior procedure has a 5.2% rate of complication. However, posterior has a relatively lower rate of 5.1%, while combined procedures have a complication rate of 10.2%. In contrast, results from an analysis of data from the Kids' Inpatient Database (KID) show an increased complication rate of 22.3%, after IS fusions [3]. According to Menger et al., the National Inpatient Sample database (NIS) shows that complications after IS surgery operation for correction were approximately 0.9% neurological complications, 2.8% for respiratory complaints, 0.8% for cardiac issues, 0.4% for infectious complications, 2.7% for gastrointestinal complications, 0.1% for venous thromboembolic events, 0.1% for renal complications, and a fatality rate of 0.1% [9]. The high incidence of the complications could be as a result of patient characteristics, comorbidity state, surgical procedure, or techniques, and surgeon experience, which makes it challenging to stratify risks. It is essential to identify risk factors for complications among patients. Also, spine surgeons should be equipped with knowledge and readiness for potential complications.

Neurologic Injury

Neurologic injury is the most feared complication after scoliosis surgery. The injuries can result in transient neuropraxia linked to body position, and even damage to the spinal cord leading

to total paralysis. Such injuries have been estimated between 0.3% and 4% [10]. The incidence is influenced by the surgical approach technique or the type of implant applied. Research indicates that neurologic impairment was found to be 0.73% [10]. Furthermore, other studies show that neurologic injury occurred in 0.69 to 1.06% of IS spine fusion cases, which varied across different surgical approaches used [11,12]. The surgeons involved in the process should understand the causes of neurologic injury along with the associated types of complications. At times, correcting deformity could more likely overstretch the spinal cord. Intraoperative hypotension and stretching of the small arteries could result in lower perfusion to the spinal cord. Neurophysiological detection of impending spinal cord injuries is used to detect such impairments to aid the early detection and prevention of this complication [13].

According to Vitale et al., the respective specificity and sensitivity of electrophysiology was 88% specific and 100% respectively during diagnosis of neurologic deficits [14]. Intraoperative neuromonitoring should be carefully performed by ensuring full control in a systematic approach to decrease any risk of neurologic damage. The onset of spinal cord injuries can delay despite them occurring intra-operatively. Auerbach et al. report that prolonged neurologic deficiencies occur in 0.01% probability [15]. This highlights the role of post-operative serial neurologic investigations for IS patients. A full spinal examination should be conducted on all patients, regardless of previous postoperative neurologic results. Once the postoperative neurologic deficit is encountered, imaging studies can be used at first followed by guided management of the deficit, which may require decompression and implant exchange. The study further states that 75% of the affected individuals conducted imaging investigations before repeat surgeries [15]. Hence, this proves the delay in the onset of the neurologic deficit. Thus, pre-operative spinal imaging (CT scans or MRIs) are useful, to help surgeons in improving accuracy during the determination of sources of any compression or when locating implants that require replacement. According to Coe et al., 61% completely recovered from while 33% made an incomplete recovery. However, increased chances of recovery are observed among individuals with compression related delayed onset neurologic deficits than those with ischemia.

Dural Tears

In IS surgeries, dural tears and dura exposure occur mostly when the deformity is either rigid or severe. Therefore, this is not common in most patients, where dural tears occur between 0.12 and 0.26%. This can be repaired by sealing tears using a supplemental patch or fibrin glue. Post-operative management will include monitoring of drain output, extended systemic antibiotics, and limited mobilization after surgery.

Position-Related Complications

The surgeon has to know the precise positioning of spinal fusion patients. In posterior IS fusions, patients will be in the prone position for a given amount of time. Therefore, surgeons, anesthesiologists, and circulating nurses must ensure

proper positioning and that the bony prominences are well padded and safe. This prevents common complications such as ophthalmologic injury, peripheral nerve neuropathy, and brachial plexopathy. Other issues associated with positioning include brachial plexopathies and lateral femoral cutaneous nerve palsies. The complications occur in approximately a frequency of 0.5%, which can be reduced by ensuring the proper positioning. Despite the perioperative visual loss (POVL) being rare, it is the most devastating complication for an individual after scoliosis surgery. Myers et al. report 37 instances of ophthalmologic injury [16], while Ramos et al. indicate an occurrence of 0.16% [17]. It is common in younger patients with a health record of pre-existing anemia, and those undergoing long-segment fusions.

Blood Transfusions

Spine surgeons understand that scoliosis surgery leads to the loss of large volumes of intraoperative blood which require the transfusion of blood product [18]. The significant risk factors are the female gender, longer segment fusions, and fusions involving the lumbar spine [19]. A study indicates that 25.1% of all patients have undergone blood transfusion [20]. However, approaches have been implemented to reduce blood transfusion, such as hypotensive anesthesia, among others [21].

Gastrointestinal (GI) Complications

Gastrointestinal issues are common during the post-operative period after IS surgery. According to Menger et al. found that 2.7% of 75106 spinal procedures caused postoperative GI morbidity [9]. Risk factors, in this case, are opioid use, medical comorbidities, and fusion procedures. Early postoperative mobilization, post-operative epidurals, and multimodal non-narcotic pain control medications are the interventions that the surgeon should adopt to reduce this complication.

Infection and Wound Complications

In IS patients, the SSI rate ranges from 0.17% to 9%, based on the patient population under consideration [22]. In a study, results indicate a rate of 0.5% and 0.8% for superficial and deep wound infections, respectively. On the other hand, a study indicates that IS has a prevalence of 2.6% [23]. Risk factors include Non-idiopathic scoliosis and extension of instrumentation to the pelvis, blood transfusions, and medical histories [23]. Delayed onset is observed up to more than six months after the procedure [24,25]. Early management of wound infections by debridement and irrigation along with the assessment of the implant and the extent of the infection, retaining, exchanging, or even removal of implant should be considered. A combination of this treatment with the infectious disease with antibiotics will provide effectiveness. Most cases can be treated using antibiotics, debridement, and irrigation. Also, serially-applied closed negative pressure dressing systems can be crucial for patients with wound dehiscence and deep infection. Investigations conclude that oral antibiotic therapy is linked to a shorter length of hospital stay and with fewer complications compared to intravenous therapy [26]. However, Di Silvestre et al. report that all patients suffering from delayed-onset

infection after fusion surgery for IS required implant removal as part of the infection treatment [27]. Despite being a rare case in IS patients, early- and delayed-onset infections should be prevented in early stages. Furthermore, surgeons should apply the best practice guidelines in the process of formulating their procedures for SSI prevention.

Thromboembolic Events

In adults, thromboembolic is usually recognized as a spine surgery complication, with the major causes being vein thrombosis and pulmonary embolisms. However, 21/10,000 is a rate in which VTE is not frequent within pediatric scoliosis [28]. The risk factors are syndromic and congenital scoliosis. The development of VTE can take weeks or months after surgery. Presently, there are no recommendations that guide the surgeons on VTE's prevention and treatment in the IS patients. Apart from hematological risk factors, VTE has not been witnessed in the IS patients' age group. Pulmonary complications frequently occur after IS spine surgery; however, their characterization is still poor. Such complications have a reported incidence of between 0.6 and 3.5% [3]. Nevertheless, the reports on the direct correlation between post-operative and pre-operative pulmonary function tests are conflicting [29,30]. Through further research, the definition, and classification of the complications can be enhanced.

Implant-Related Issues

Implant complications comprise of 0.64 % to 1.34 % of all complications in IS spinal surgeries [8]. The complications could result from rods, hooks, or screws. Despite many studies proving the application of pedicle screws as effective and safe for treatment [31] numerous reports refer to issues caused by pedicle screw placement [32] for instance, the complications are affecting the neural structures, wear debris, dural tears, wound complications, pleural effusion, and pneumothorax [33].

Other Co-Morbidities And Fatality

Data for 36,355 patients who underwent corrective surgery measures for IS by observing Nationwide Inpatient Sample (NIS) was analyzed. The data was gathered from the NIS databases from 2002 to 2011 [34]. Ramos et al. concluded that the risk for the postoperative complications of spinal fusion was approximately 7.6%, with 0.2 % or less incidence for significant individual complications. The complications include pancreatitis, Disseminated Intravascular Coagulation (DIC), and visual loss, spinal cord injury, cardiac arrest, sepsis, nerve root injury, DVT, PE, shock, malignant hyperthermia, myocardial infarction, and iatrogenic stroke. However, the fatality rate was less than 0.2%.

Pseudarthrosis

The pseudarthrosis rate for IS patients was reduced to approximately 1%. It is as a result of improved understanding of the pathology along with enhanced surgical techniques and instruments, incorporating intra-articular fusion. Through a systematic review, symptomatic pseudarthrosis, following non-instrumented fusion,

and instrumented fusions were found to have frequencies of 22.7% and 2%-7%, respectively [35]. In a meta-analysis of 1565 instrumented posterior spinal fusions, pseudarthroses were found to be 2%. Regarding this, the instances were less frequent with Cotrel-Dubosset constructs (2%) than with Harrington rods (3%). There was no pseudarthrosis in the 254 patients with all pedicle screw fixation [5]. Pseudarthrosis occurs in various parts of the body. For example, they occur at the thoracolumbar junction and the distally fused segment. Pseudarthrosis may not showcase signs for a considerable time with implants that are stronger and more rigid. The condition can be found through the application of bone scans, computed tomography, or oblique radiographs. The definitive diagnosis can be obtained during surgical exploration.

Curve Progression

The curve progression is among the most frequent causes of revision, at a rate of around 1%. Having undertaken 1057 IS fusions, Luhmann et al. [36] discovered that 4 % of patients were necessary for reoperation. The majority of patients were for pseudarthrosis (26%) or infection (34%). Around 2% of the patient samples were necessary because of curve progression in the adjacent unfused segment. The “adding-on” phenomenon is a curve progression at a level below that of spinal fusion [37-39]. The reports have indicated that it occurs between 2% - 5% of subjects [37] Cho et al. found out that notable predictors of adding-on were age and Risser grade. This suggested that patients with greater growth potential had a higher risk of curve progression below the fusion. Nevertheless, the study also identified the variations between two subtypes of Lenke 1A curves. Regarding this, the chances of adding-on were doubled for curves with an L4 tilt right rather than left. The risk factors identified by Wang et al. [38] include preoperative deviation for the first level distal to the lowest instrumented vertebra of over 10 mm, a difference higher than one level for stable vertebra minus lowest instrumented vertebra, and patient age of 14 years or less.

Conclusion

Spinal fusion surgery offers a means of deformity correction that is both effective and relatively safe for the IS patients. The report compiled by the surgeons indicates complications in between 5% and 25% of cases. Therefore, it is important for spine surgeons who treating Idiopathic scoliosis patients to be well conversant with the nature as well as management of potential complications. Furthermore, before the surgical intervention takes a place, patient and family counseling is paramount including the possible complication, risks, and benefits.

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