Unplanned surgery of congenital scoliosis

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To the Editor: There is a high probability of requiring unplanned surgery for congenital scoliosis (CS), but very few publications have reported the proportion of unplanned surgeries, the causes of those unplanned surgeries, and the prevalence of each cause. This study aimed to provide more information regarding the above. We reviewed the electronic medical records of patients with CS that underwent unplanned surgeries at our hospital from 2009 to 2018. By searching the database of West China Hospital, we found 317 CS cases. Of these, 33 cases underwent unplanned surgeries, of which five had their primary surgeries at outside hospitals. The unplanned surgery rate in our case series was 9.0% (28/312). In our case series, the most common cause of unplanned surgery for patients with CS was progressive deformity (49%, 16/33), followed by implant-related complications (36%, 12/33), wound-related complications (12%, 4/33), and surgical error-related complications (cerebrospinal fluid [CSF] leak, 3%, 1/33). The most common reason for unplanned surgery in CS was progressive spinal deformity or imbalance, which accounted for 49% (16/33) of the unplanned surgeries.

This retrospective study protocol was approved by the Ethics Committee of West China Hospital, Sichuan University (No. 2019852) and with a waiver of consent. We included all patients with CS who underwent unplanned surgeries at our institution. Unplanned surgery is any surgical procedure after primary surgery that is caused by surgical error, implant failure, wound complications, or deteriorating conditions. We identified our cohort by performing a computerized query of all patients admitted to our hospital between 2009 and 2018. We used International Classification of Diseases (ICD) codes "ICD-10: Q67.5 or Q76.3" and searched for key terminologies, such as "CS," "hemivertebra," or "unsegmented vertebra." This initial search yielded 317 unique patients. Screening electronic medical records yielded 33 eligible patients based on the following inclusion criteria: (1) age <18 years at the time of original surgery; (2) had unplanned surgery at our hospital; and (3) at least 24 months of follow-up. The primary outcomes were the causes of the unplanned surgeries in CS patients. We divided the causes into four categories: surgical error-related complications, wound-related complications, implant-related complications, and progressive spinal deformities or imbalance.

Thirty-three cases, consisting of 16 females (48%) and 17 males (52%), met our inclusion criteria [Figure 1A and Supplementary Table 1, http://links.lww.com/CM9/A778]. Of these, 28 patients had their original surgeries at our hospital, and 5 patients had their original surgeries at other hospitals. Therefore, the unplanned surgery rate for CS at our institution was 9% (28/312). Of our 33 CS cases with unplanned surgeries, 26 cases (79%) had received posterior hemivertebra resection, screw-rod fixation, and bone graft fusion in their original surgery. Two cases with two adjacent unsegmented vertebrae had only bone graft fusion in their original surgeries. Three cases had posterior screw-rod fixation and bone graft fusion without resection of abnormal vertebrae in their original surgeries. Of these three cases, two cases had wedge-shaped vertebrae, and their original surgeries were conducted at outside institutions, and the third case had a butterfly vertebra and unsegmented vertebrae. Two other cases were treated with growing rods and subsequently underwent hemivertebrae resection, fixation, and fusion as their original surgeries. After the original surgery, radiographic parameters had significantly improved. The most common cause of unplanned surgery in our 33 CS cases was progressive spinal deformity, which was responsible for 49% (16/33) of all cases, including progressive scoliosis (7 cases), progressive kyphosis (6 cases), and progressive scoliokyphosis (3 cases). Other causes of unplanned surgery, in decreasing order, were implant-related complications

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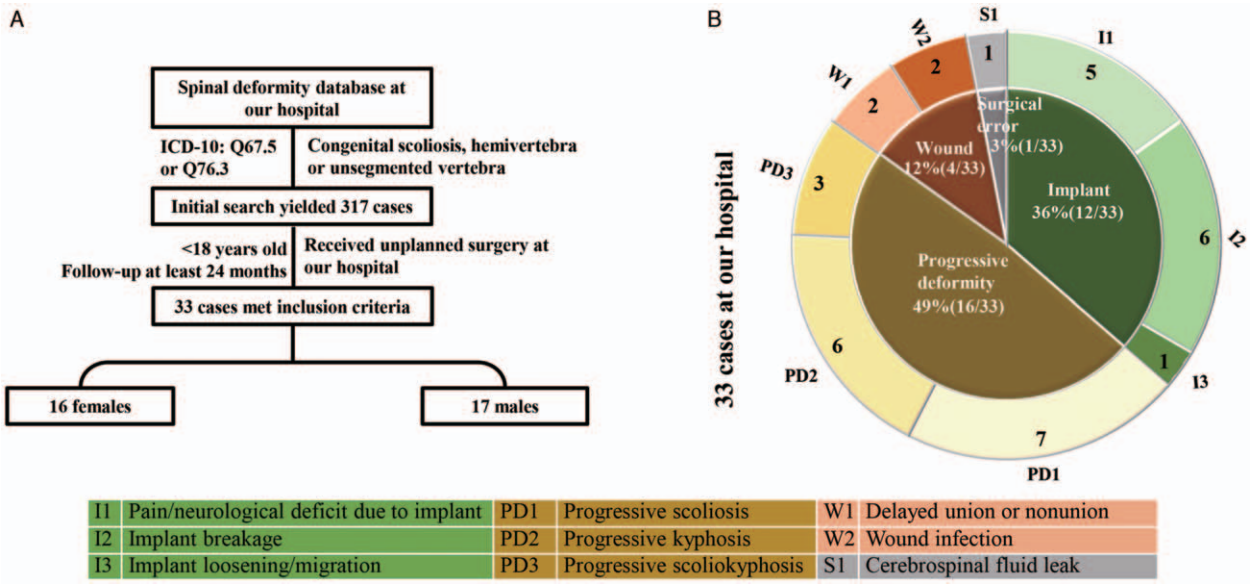

Figure 1: Cases of CS that underwent unplanned surgery: (A) Flowchart of inclusion criteria. (B) Causes of unplanned surgeries in our CS cases ($n = 33$). CS: Congenital scoliosis; ICD: International Classification of Diseases.

(36%, 12/33), wound-related complications (12%, 4/33), and surgical error-related complications (3%, 1/33) [Figure 1B].

From reviewing the literature, we found that improper implant removal, suboptimal surgical strategy, implant failure, and surgical errors can cause progressive spinal deformity or imbalance. Implant removal is primarily performed due to late surgical-site pain or discomfort from implants, implant breakage, or patient's request.[1,2] Five of our CS cases had implant removal secondary to surgical-site pain, implant protrusion-related discomfort, or patient's request and subsequently developed progressive spinal deformity. Within 2 years after implant removal, all five of these cases underwent reoperation due to fracture of bony fusion mass and progressive spinal deformity. The recurrence of spinal deformity could possibly be due to the nature of growing children or incomplete circumferential fusion after the original surgery. Therefore, implant removal in growing patients should be avoided unless it is absolutely necessary. Patients require close follow-up, especially during the first 2 years after implant removal and during growth peaks.[1]

Suboptimal surgical strategies included only posterior epiphyseal arrest, incomplete or no resection of the malformed hemivertebrae, no bone graft utilization at the instrumented segments, wrong selection of end instrumented vertebra, long segmental fusion at a young age, and no treatment of adjacent vertebral deformity. Seven of our cases had suboptimal original surgeries, of which five were performed at outside hospitals, and subsequently developed progressive spinal deformities. Three of the cases had received only rigid fixation and fusion of the abnormal vertebrae without resection of the hemivertebrae; two of the cases had incomplete resection of the hemivertebrae; and two of the cases had only posterior fusion of unsegmented L2–L4 vertebrae or unsegmented T1–T2 vertebrae. For CS cases with fully segmented hemivertebrae, hemivertebrae resection, short fixation, and short fusion should be conducted.

Even with the optimal surgical strategies, some CS cases will still develop recurrent spinal deformities. This occurred in four of our cases that developed structural S-shape scoliosis after posterior resection of hemivertebrae with short fixation and fusion. The hemivertebrae had been completely resected with the adjacent growth plates, and fusion was well achieved. There was no pseudoarthrosis, implant failure, or any other obvious reason to explain the recurrence of progressive scoliosis after the original surgery. A potential explanation may be that the original surgery altered the preoperative coronal balance, so the preoperative compensatory curve may progress further within 6 months after the original surgery to achieve a new spinal balance, forming a structural S-shape scoliosis. These four cases ultimately underwent unplanned surgeries due to severe recurrent spinal deformities. In the early stages of the development of recurrent scoliosis after the original surgery, when the spinal curve is mild and flexible, conservative treatment with brace application is recommended to prevent further progression of scoliosis. The brace may help control the progression of recurrent scoliosis, but there is a high probability of revision surgery.[3] When there is a rapid or advanced progression of recurrent scoliosis, such as when it becomes rigid and reaches 45°, revision surgery needs to be considered.[3]

Implant-related complications, including implant-related pain, discomfort, or neurological deficit and implant failure, were the second most common cause for unplanned surgeries in CS patients in both our case series and the literature. Five of our 33 cases developed late surgical-site pain. After careful evaluation, no other cause for the pain was found, except possibly implant-related

pain. Implant removal significantly relieved the pain, so these five cases were categorized as implant-related complications. For implant-related pain that failed conservative treatment, implant removal is necessary after careful evaluation.

Implant failure included implant breakage, loosening, pull-out, and migration. Seven of our cases received unplanned surgery due to implant failure: five cases had implant removal after confirming solid fusion; one case had replacement of the broken growing rod; and one case with screw breakage and progressive scoliosis underwent osteotomy, fixation, and bone graft fusion. Implant failure can result from the lack of complete resection of the malformed hemivertebra or the lack of bone graft, the use of improper fixation instruments, and the improper selection of fixation and fusion segments. When growing rods are not molded sufficiently with the kyphosis contour on the sagittal plane of the rods, this can cause the hook to displace during spinal growth.[4] Other causes of implant failure include inadequate solid fusion, fast growth, poor bone quality, and small pedicles. To help prevent implant failure, there are several suggestions to be followed preoperatively, perioperatively, and postoperatively. During surgical planning, 3D reconstruction of the pedicles via computed tomography (CT) imaging can be used to select the proper implants for young CS patients.[5] During surgery, the entire hemivertebra, including both endplates, should be resected. Furthermore, the contralateral bar and rib synostosis should be resected prior to compression. For cases with large hemivertebra or obvious kyphosis, it is recommended that a mesh cage be used to reconstruct the anterior column and correct the kyphosis, providing postoperative stability. Postoperatively, wearing a spinal brace may help improve fusion outcomes.

The third most common cause of unplanned surgeries in CS cases was wound-related complications, including delayed wound union or nonunion, deep or superficial wound infection, and surgical-site hematoma. The proportion of unplanned surgeries in CS patients caused by wound-related complications was 12% in our case series. Inadequate wound healing is usually caused by excessive tension on the skin at the incision site. Children often have weak back muscles, and the use of high-profile head screws may increase the tension on the skin.[6] Wound infections are commonly caused by contaminated surgical materials or poor hygiene at the surgical site. In addition, most CS patients have underlying diseases that cause immunodeficiency, thus increasing the possibility of infections.[6] Therefore, good hygiene during and after surgery and proper care are important for preventing wound infections. Moreover, surgical-site hematomas can be prevented with postoperative catheter drainage. The fourth most common cause of unplanned surgeries in CS patients was surgical error-related complications, including CSF leak, implant misplacement, and intrapleural effusion. In our case series, only 1 out of the 33 cases (3%) had a surgical error-related complication (CSF leak).

In summary, we reviewed 33 cases of CS that underwent unplanned surgeries at our hospital as well as 364 cases from the literature. The rate of unplanned surgery in CS patients was 9% (28/312) at our hospital. In our case series as well as in the literature, progressive spinal deformity or imbalance was the most common reason causing unplanned surgeries in CS, followed by implant-related complications and wound-related complications. It is important that spinal surgeons be aware of the common causes and prevalence of unplanned surgeries in CS and inform patients of potential unplanned surgeries when discussing the risk of surgery in CS.

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Conflicts of interest

None.

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