Soft-tissue defects after spinal instrumentation in 5 children: risk factors, management strategies, and outcomes

Clinical article

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Object. Wound-related complications following complex posterior spine procedures in children may result in the need for serial debridements and may place spinal instrumentation at risk. In this study, the authors review their experience with the management of soft-tissue defects from spinal instrumentation in 5 high-risk pediatric patients. The use of various rotational and transpositional flaps in the management of these complicated cases is discussed, as well as their outcomes.

Methods. The authors retrospectively reviewed the medical records of 5 patients who returned to the Neuro-Spine service at Texas Children’s Hospital for erosion of spinal instrumentation through the skin between September 1, 2007, and October 31, 2012. Patient demographics and clinical and operative data were recorded.

Results. Risk factors such as young age (1 case), poor nutritional status (1 case), multiple previous surgeries (3 cases), severe neurological deficits (2 cases), and history of radiation therapy for malignancy (2 cases) were noted in the 5 patients. The paraspinous flap (4 cases) was the mainstay of the treatment. Follow-up ranged from 7.5 to 17.5 months (mean 11 ± 4.2 months). One of the patients required more than 1 procedure for revision of the wound. Cultures were positive in 2 of the 5 cases. Spinal instrumentation was removed in 3 of the 5 cases; however, in all 3 of the cases there was evidence of delayed instability that developed after the removal of spinal instrumentation.

Conclusions. The use of local tissue flaps is safe and efficacious for treatment of posterior wound complications due to spinal instrumentation in children. Removal of spinal instrumentation should be avoided due to the development of delayed instability. Highly vascularized tissue is used to speed healing, clear bacteria, and eliminate dead space, obviating the need to remove contaminated spinal instrumentation. (http://thejns.org/doi/abs/10.3171/2014.8.PEDS13664)

Key Words • spinal instrumentation • erosion • wound infection • pediatric spine

Wound dehiscence after spinal instrumentation in the pediatric age group presents a challenging problem to the spine surgeon and plastic surgeon.11,13,17,19,21,22,26 Soft-tissue complications after spinal instrumentation are most commonly observed in patients with young age, poor nutritional status, severe disability from neurological deficits, multiple previous surgeries, and malignant neoplastic disease necessitating adjuvant therapy.17,19 In the pediatric age group, these risk factors are found most commonly in children with spinal dysraphism and neuromuscular spinal deformities, and in the presence of radiation therapy prior to spine surgery. The removal of all prominent components of the spinal instrumentation that may be the offending member causing skin erosion or contaminated with bacterial biofilm may be the most important step in the effective treatment of complex soft-tissue defects.18 However, removal of spinal instrumentation risks the development of delayed spinal instability in this fragile patient population. The recruitment of richly vascularized tissue is often necessary to provide healing and viable skin coverage.
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for exposed instrumentation. Vascularized muscle flaps have been shown to be highly effective in adults for complicated soft-tissue defects with extruded spinal instrumentation, resulting in infection control and wound coverage. However, limited experience exists with the use of these techniques in children. In most circumstances, the decision for the specific type of soft-tissue reconstruction is left to the plastic surgeon. Nevertheless, the pediatric spine surgeon should be familiar with the preparation of a suitable site for a soft-tissue graft and the soft-tissue flaps available to help plan reconstruction.

We review our experience and outcomes with various muscle flap management strategies in 5 children with spinal instrumentation that eroded through the skin. We also examine the patient risk factors that may have contributed to this complication.

Methods

We retrospectively reviewed 5 cases from 128 children treated using spinal arthrodesis and instrumentation by the Neuro-Spine Program at Texas Children’s Hospital from September 1, 2007, to October 31, 2012, who returned to our institution because of spinal instrumentation erosion through the skin. The medical records and radiological imaging of the 5 patients were reviewed to determine the age and sex of the patient, duration of the operation, perioperative use of antibiotics, intraoperative blood loss, type of bone graft used, length of the fusion, number of hooks/ pedicle screws/sublaminar polyester bands/crosslinks used, presence of risk factors (such as poor nutrition, neurological deficits, repeat surgery, and malignant neoplastic disease associated with prior radiation therapy), duration of follow-up after the initial operation, duration and location of pain, concomitant infection and culture results, white blood cell (WBC) count/erythrocyte sedimentation rate (ESR)/ C-reactive protein (CRP) level, condition of the hardware (intact or fractured) during removal, status of the fusion (pseudarthrosis, healing, or strong bridging fusion mass), type of procedure used to repair soft-tissue defect (removal of instrumentation vs salvage of instrumentation, and vascularized muscle flap), antibiotic treatment, and outcomes (Tables 1 and 2).

Case Reports

Case 1

History and Examination. Case 1 was a 15-year-old boy with a history of myelomeningocele status post repair, ventriculoperitoneal shunt placement shortly after birth for hydrocephalus, and congenital kyphosis. He developed a sitting imbalance in his wheelchair because of the spinal cord with maximal transverse dimension measuring 1.3 cm, basilar invagination, a retroflexed odontoid with the medulla draped over the dens with crowding and distortion of the neural structures in the foramen magnum, and no CSF flow noted ventral to the brainstem.

Clinical Course and Follow-Up. The patient underwent 2 attempts at cervical syrinx marsupialization followed by instrumented occiput to C-5 fusion (Fig. 1) in September 2011. He presented 4 months later with evidence of hardware erosion at the occiput. The hardware was removed, but incomplete fusion was noted at the time of surgery. The splenius capitis muscles were advanced to obliterate the dead space. Unfortunately, the patient experienced progressive basilar invagination with further enlargement of a cervicomедullary syrinx, indicative of slow delayed instability at the cranio cervical junction. He therefore underwent a second occipitocervical fusion in July 2013 to treat his instability, 17 months after his hardware erosion and removal. At his most recent surgery, splenius capitis advancement flaps were again used to cover the instrumentation. He was examined at the 3-month follow-up, and his wound was noted to be healing well. There was also bridging bone documented as assessed by CT.

Case 2

History and Examination. A 3-year-old boy with a component of congenital scoliosis from hemivertebra and neuromuscular scoliosis from a tethered spinal cord was treated initially at 9 months of age with an eggshell osteotomy of the hemivertebra, as well as a short-segment fusion of the apex of the deformity. The spinal deformity continued to worsen despite surgery and bracing treatment. Full spine radiographs demonstrated a progression of his spinal deformity from 61° to 73° over a period of 3 months.

Clinical Course and Follow-Up. The patient subsequently underwent placement of a growing rod construct from T-4 to the ilium (Fig. 2). The inferior end of the construct had always been prominent, and he developed a chronic seroma around the tip of the rod. Eighteen months after the surgery, the subcutaneous fluid collection ruptured. The spinal instrumentation was visible through a sinus to the skin. The decision was made at that time to remove the spinal instrumentation because of exposure to the environment and concern for infection, although there were no signs of infection at the time.

Postoperatively, there has been progression of his spinal deformity and he is currently undergoing treatment with a detorsional scoliosis brace. Definitive posterior instrumented fusion is planned once he reaches skeletal maturity.

Case 3

History and Examination. A 16-year-old boy had a history of myelomeningocele status post repair, ventriculoperitoneal shunt placement shortly after birth for hydrocephalus, and congenital kyphosis. He developed a sitting imbalance in his wheelchair because of the spinal

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deformity pitching him forward, restrictive lung disease from compression of his rib cage as a result of the spinal deformity, skin breakdown over the bony gibbus of the congenital kyphus, and difficulty with catheterization and feeding tube administration because of his abnormal body habitus. The patient was paraplegic. Full spine radiographs showed an acute kyphosis centered at L1–2, measuring 73°.

Clinical Course and Follow-Up. A kyphectomy and posterior instrumented fusion from T-8 to the ilium was performed (Fig. 3). Four and a half months after the initial operation, there was a breakdown over the caudal end of his construct over the bilateral iliac screw heads. The left side improved and healed, but the right side continued to breakdown, leaving a relatively large soft-tissue defect measuring approximately 2 cm in diameter with spinal instrumentation exposed at the depth of the wound. The wound was washed out and repaired with a musculocutaneous advancement flap without removal of any spinal instrumentation. The intraoperative wound culture was positive for rare Pseudomonas aeruginosa. The patient completed a 6-week course of intravenous ceftazidime and a 12-month regimen of levofloxacin for suppressive oral antibiotics. At the 12.5-month follow-up after the revision, the wound was healed without any signs of infection.

Case 4

History and Examination. A 10-year-old boy presented with hip pain and a right-foot drop. MRI demonstrated a spinal and paraspinous mass lesion centered at L-2.

Clinical Course and Follow-Up. An open biopsy showed undifferentiated sarcoma. The patient was started on a protocol involving radiation and chemotherapy. Just 4 weeks after radiation therapy, and in the middle of his course of chemotherapy, he underwent aggressive resection with posterior instrumented fusion (Fig. 4A). The patient resumed his chemotherapy regimen postoperatively. Approximately 5 months following surgery, he presented with erosion of the instrumentation through his skin and was admitted with neutropenia. Following chemotherapy and upon recovery of his WBC count, the decision was made to remove the prominent crosslink and advance a paraspinal muscle flap. Six months after the first revision, instrumentation erosion through the skin occurred again (Fig. 4B), and a right flank rotational flap was advanced, as well as a full-thickness skin graft from the right upper back. One and a half months after the second wound revision, a necrotic eschar began to form over a prominent screw head as well as the donor site, where a full-thickness skin graft from the upper back was used to cover the donor site. Because of imminent erosion of instrumentation through the skin, the patient was again taken to the operating room for a latissimus dorsi rotational flap (Fig. 4C). Approximately 3 months later, he again presented with hardware exposure at the same site that had been closely watched for several weeks. At this point, because recent cultures grew skin flora, he was taken to the operating room for washout and placement of antibiotic beads for hardware sterilization. One week later, he was taken to the operating room where AlloDerm (LifeCell) was placed over the area of prominent hardware and then a left latissimus dorsi myocutaneous rotational flap was used to cover the defect. A week and a half after this surgery, the wound opened while he was turning over, leading to exposed hardware. He was thus taken back to the OR for washout and re-advancement of the latissimus dorsi myocutaneous flap and placement of a wound vacuum-assisted closure.

At 2 months after the last wound revision, the patient is doing well. Close observation of the wound has not shown any evidence of breakdown or erosion of spinal instrumentation through the skin. The patient continues to receive Bactrim (trimethoprim/sulfamethoxazole) for oral antibiotic suppressant therapy.

Case 5

History and Examination. A 10-year-old boy with a history of myelomeningocele repair at birth and congenital kyphosis presented with a nonhealing ulcer over the bony gibbus of his spinal deformity. He was paraplegic and wheelchair bound. Full spine radiographs showed an acute kyphosis centered at L1–2 measuring 131°.
<table>
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<th>Case No.</th>
<th>Time Since 1st Op (mos)</th>
<th>Culture Results</th>
<th>Serum Albumin (dl)</th>
<th>Status of Fusion†</th>
<th>Reconstructive Procedure</th>
<th>Type &amp; Duration of Prescribed Antibiotics</th>
<th>Follow-Up (mos)</th>
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<td>5</td>
<td>NA</td>
<td>5.46/NA/NA</td>
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<td>11.38/5/0.98</td>
<td>NA</td>
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<td>Pseudomonas aeruginosa (rare)</td>
<td>8.24/47/1.8</td>
<td>solid fusion</td>
<td>advancement of paraspinal muscle flap (1st revision), rotation of rt flank flap (2nd revision), rotation of latissimus dorsi flap (3rd revision)</td>
<td>cefotaxime (for 3 days postop), then transition to cefazidime &amp; vancomycin for 6 wks, levofloxacin for 1 yr</td>
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<td>S. aureus (rare, methicillin-sensitive)</td>
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<td>primary wound closure w/ paraspinal muscle &amp; fascia reapproximation</td>
<td>vancomycin, cefazidime, &amp; metronidazole for 3 days, cefazolin for 4 wks</td>
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* Only Case 2 had signs of infection (clear drainage only). chemo = chemotherapy; NA = not applicable; TMP/SMX = trimethoprim/sulfamethoxazole.
† According to preoperative CT.

**TABLE 2:** Data on the 5 patients with soft-tissue defects, including time to erosion, signs of infection, status of fusion, duration of antibiotic therapy, and type of reconstructive procedure.*
Clinical Course and Follow-Up. The patient underwent a T12–L2 kyphectomy and a T9–ilium posterior instrumented fusion (Fig. 5A). His postoperative course was complicated by an asymptomatic fracture of both iliac screws at 9 months after surgery. He was followed up and he subsequently developed skin breakdown over the caudal end of the spinal instrumentation on the left side. Twenty-five months after surgery he developed some drainage from his lower-left iliac wound site, but this healed with conservative antibiotic treatment. Frank exposure of spinal instrumentation through the wound was identified at 28 months after the initial surgery. A CT scan obtained before removal showed a solid fusion mass (Fig. 5B). A decision was then made to remove all the spinal instrumentation at the same time as an advancement of the paraspinous muscles. Wound cultures returned positive for rare *Staphylococcus aureus* susceptible to methicillin, and an intravenous and oral antibiotic regimen was initiated. Postrevision CT conducted 2 months after surgery revealed an acute fracture through the apex of the kyphotic deformity (Fig. 5C). The patient was fitted with a thoracolumbosacral orthosis for 5 months. Follow-up CT showed bulky new bone formation across the apex with some loss of correction from the initial surgery.

Because of a residual bony gibbus combined with prolonged brace wear, there was some minor breakdown of the skin. At 9 months after wound revision, the patient has healed satisfactorily without any signs of infection.

Results

We reviewed 5 patients who were treated for soft-tissue defect after spinal instrumentation at our institution. They were all male. These patients were followed for a mean of 11 months (range 7.5–17.5 months). The average duration of the operation was 445.8 minutes (range...
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221–710 minutes), and the average estimated blood loss (EBL) was 400 ml (range 50–1200 ml). All patients received cefazolin before the incision and at least 2 doses postoperatively. An average of 6.6 vertebral levels (range 3–12 levels) was included in the arthrodesis. A total of 6 sublaminar polyester bands, 34 pedicle screws, 4 iliac screws, and 5 crosslinks were used in these 5 patients. Three patients were managed with bone morphogenetic protein (BMP) and allograft; 1 patient underwent fusion with BMP, allograft, and local autograft; and 1 patient with congenital scoliosis and a growing rod construct did not undergo arthrodesis. None of the patients underwent blood transfusion in the perioperative period.

Risk factors were identified for the 5 patients. Patient age ranged from 3 to 16 years, with a mean age of 10.8 years. One patient demonstrated poor nutrition with a serum albumin level of 3.2 g/dl (normal reference range 3.5–5.0 g/dl). Two patients carried the diagnosis of spinal dysraphism, specifically myelomeningocele, with significant neurological deficits. Three patients had previously undergone spine surgeries. Two patients had a concurrent diagnosis of cancer (posterior fossa ependymoma and paraspinal undifferentiated sarcoma).

Two patients who had erosion of spinal instrumentation through the skin had an acute postoperative infection or signs of impending postoperative infection. The postoperative infections were diagnosed at 5 months (Case 3) and 28 months (Case 5), respectively, after the initial operation.

Fig. 4. Case 4. A: Intraoperative photograph showing L1–3 posterior instrumented fusion after laminectomy and right L-2 transpedicular resection of a paraspinous tumor. The thecal sac and right L-2 nerve root are skeletonized. B: Postoperative photograph of the lower back showing erosion of a pedicle screw head through the skin. C: Postoperative photograph of the lower back demonstrating an area of necrosis and eschar over a prominent screw head and donor graft site.

Fig. 5. Case 5. A: Postoperative upright lateral full-spine radiograph showing a T9–ilium posterior instrumented fusion after kyphectomy. B: Sagittal CT scan prior to removal of spinal instrumentation demonstrating solid arthrodesis. C: Sagittal CT scan after removal of instrumentation demonstrating a new fracture through the bone fusion mass.
One patient had pain at the site of surgery before the development of a soft-tissue defect and exposure of spinal instrumentation. Spontaneous drainage occurred in 1 patient, directly over a component of the spinal construct. One patient had fluctuance over the spinal instrumentation. The average WBC count, ESR, and CRP level were 7.1 cells/μl (range 4.87–11.38 cells/μl), 42 mm/hour (range 5–62 mm/hour), and 2.1 mg/L (range 0.5–5.3 mg/L), respectively, at the time of revision.

Three patients were taken to the operating room for removal of instrumentation. Two patients demonstrated a partially healed fusion mass at the time of wound revision, and 2 patients had completely healed fusion masses. Primary wound closure was performed in all 5 cases; 2 cases were closed over drains. Muscle flaps advanced for soft-tissue coverage included bilateral semispinalis capitis flap (1 patient), latissimus dorsi flap (1 patient), and paraspinal muscle flap (4 patients).

Cultures of specimens from the open wounds were performed for all patients. Pseudomonas aeruginosa was identified in 1 patient and methicillin-susceptible Staphylococcus aureus was identified in another patient. No organisms were cultured in 3 patients.

Intravenous antibiotics were administered to all patients for 7 to 21 days; 3 patients then received oral antibiotics for 4 weeks to 12 months. All wounds healed uneventfully, except Patient 4, who has since required 5 additional surgeries and currently has a wound vacuum-assisted closure in place. All patients with removal of spinal instrumentation developed delayed instability, which manifested as slowly worsening basilar invagination (Case 1), progressive scoliosis (Case 2), and a new fracture through a previous solid arthrodesis (Case 5). One patient (Case 5) necessitated prolonged external rigid orthosis wear, and another patient (Case 1) underwent reinsertion of spinal instrumentation. Patient 2 is undergoing close observation and will likely need a definitive posterior instrumented fusion as he nears skeletal maturity.

Discussion

Risk Factors

Wound dehiscence and infection cause significant morbidity in children who undergo spine surgery with instrumentation. A number of risk factors have been identified that contribute to wound complications in the adult patient population including smoking, medical comorbidities (such as obesity, diabetes, or rheumatological diseases), perioperative steroid agents, negative protein balance, multiple prior operations, and radiotherapy.4,15,24 Some of these risk factors may be intrinsic to the pediatric patient, the procedure, and the postoperative care and/or management. Our 5 patients underwent an average of 2.6 operations (range 1–5 operations) before spinal instrumentation erosion, including 1 patient (Case 1) with posterior fossa tumor resection, Chiari decompression, and 2 marsupialization procedures of a syrinx, and 2 patients with myelomeningocele repair (Cases 3 and 5), prior to the initial spine surgery with instrumentation. A fourth child (Case 2) underwent an eggshell osteotomy, short-segment posterior instrumented fusion, and section of a fatty filum terminale, prior to the placement of a growing rod construct eroding through the skin. One patient (Case 4) had no prior operations before placement of spinal instrumentation that eventually eroded through the skin.

A wide variety of congenital, developmental, and acquired abnormalities may affect the pediatric spine. Decision for surgical intervention must be tailored to the disease pathology as well as each patient’s clinical situation. Placing instrumentation in the pediatric spine is challenging given the small anatomy of a child, lack of “pediatric-specific” instrumentation, and at times, inability to adapt adult techniques to the pediatric patient. “Adult-sized” spinal instrumentation may be at risk for eroding through the thin soft-tissue layers of a young child. Occipital screws and rods are placed just below the occipital scalp, where there is a distinct lack of muscle and fascia to cover this portion of an occipitocervical construct.2 Likewise, in young children with progressive spinal deformity, “growing” spinal constructs are purposefully inserted above the paraspinal muscle and fascia in the subcutaneous space to avoid auto-fusion in a growing immature spine. This procedure places the bulky instrumentation at risk for extrusion through the skin.1 In our series, 1 patient (Case 1) experienced extrusion of occult spinal instrumentation, and 1 patient (Case 2) experienced erosion of a growing rod construct.

Any condition that impairs the immune status or interferes with wound healing predisposes the patient to potential dehiscence and infection. A leading cause of such impairment is malnutrition.20,23 Several markers of malnutrition have been identified, including a serum albumin level of less than 3.5 g/dl.21 There was 1 child (Case 4) in our series with a serum albumin level less than 3.5 g/dl. Two children (Cases 1 and 3) did not have albumin levels drawn during hospitalization, but both are well below the fifth percentile for both weight-for-age and length-for-age, which could be considered signs of malnutrition.

Patients with cancer requiring operation after radiotherapy treatment are at an extremely high risk for developing wound complications.4,15,24 Radiation effects include inhibition of fibroblast outgrowth, resulting in a reduction in collagen formation and tensile wound strength.25 One strategy to decrease wound complications in patients undergoing spine surgery following radiotherapy is to use prophylactic turnover flaps at the initial surgery.25 Two of the 5 patients in our study (Cases 1 and 4) had a history of radiation therapy for cancer at 132 months and 1 month prior to spine surgery, respectively.

The occurrence of wound dehiscence and pressure ulcers is among the most common long-term secondary medical and postoperative complications in patients with spinal cord injury or severe neurological deficits.14 Pressure ulcers usually occur over bony prominences, while wound dehiscence occurs over prominent spinal instrumentation. The etiology of ulceration is multidimensional: pressure, shear, friction, moisture, and poor nutrition contribute directly to the physiological etiology of skin ulceration. Other factors associated with the development of soft-tissue ulceration include immobility and social factors, such as inadequate family and financial resource-
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es, and noncompliance with acknowledged preventative local wound care measures by caretakers. Two children (Cases 3 and 5) in our series were severely debilitated by spinal cord dysfunction from spinal dysraphism, specifically myelomeningocele. One patient (Case 3) had preexisting problems with pressure sores and skin ulceration over a gibbous deformity prior to his spinal instrumentation surgery.

Management Strategies

The removal of the most prominent portions of a spinal construct is the most important step in the effective treatment of protrusion of instrumentation through a soft-tissue defect. However, the removal of all components of the instrumentation that may be contaminated with bacteria or its biofilm is controversial. Moreover, the removal of spinal instrumentation in this fragile patient population may predispose them to delayed instability despite CT evidence of fusion before removal. In Cases 1 and 5, both patients required additional intervention to further stabilize their spines. From the experience of these 2 patients, the authors recommend against the removal of any spinal instrumentation at the initial revision, and instead advocate for the use of soft-tissue flaps to adequately cover the prominent spinal instrumentation.

The use of rotational and advancement flaps for the treatment of wound dehiscence and infection may reduce their associated morbidity. The primary advantage of turnover flaps is the advancement of nonirradiated, vascularized tissue that eliminates dead space and covers the hardware. Several authors have shown in clinical studies that the use of flaps improves wound healing and decreases bacterial contamination. Use of these flaps has reduced the incidence of instrumentation removal in patients still dependent on the implants for spinal stability. If infection has occurred before arthrodesis has consolidated (usually less than 1 year postoperatively), consideration should be given to leaving the hardware in place and suppressing the infection with antibiotics until osseous stability has taken place.

If paraspinous muscles are healthy, well vascularized, and available for mobilization, then the turnover paraspinous muscle flap is the most straightforward and direct technique to use because this group of muscles is usually available within the same operative field as the spinal instrumentation. First, skin flaps are elevated at the lateral border of the paraspinous musculature. The proper plane of dissection is superficial to the thoracolumbar fascia. Division of the thoracolumbar fascia and further dissection reveals segmental muscle perforators based laterally. With these lateral vessels under direct vision and protected, dissection proceeds along the medial undersurface of the paraspinous muscles in a subperiosteal plane. This allows the paraspinous muscles to “unfold” and be advanced toward the midline. A stepwise photographic example of paraspinous myocutaneous flaps to obtain coverage over exposed spinal hardware has been included (Fig. 6).

The trapezius muscle flap may be easily harvested through an existing midline incision. Mobilization of the trapezius is conducted from a caudal-to-rostral direction. Attachments to the scapular spine are left intact unless the flap is needed to reach the upper cervical spine. Further wound reinforcement may be obtained by reaproximation of the paraspinous muscles over the trapezius flap.

The latissimus muscle is the principle flap for reconstruction of the spine. Anatomical studies have shown that the latissimus dorsi has a dual blood supply. When the latissimus dorsi is detached at its insertion into the humerus, its vascular supply becomes based on the secondary segmental paraspinous arteries. The resulting flap is a “reverse” latissimus dorsi flap.

Fig. 6. Example of paraspinous myocutaneous flaps used for coverage of exposed spinal hardware. Photographs showing exposed hardware with erosion through the skin (A), elevation of the dermis from muscle (B), elevation of paraspinous muscle flap (C), myocutaneous flap (D), closure of paraspinous muscle over prominent instrumentation (E and F), and final closure of wound (G and H).
Other less commonly used flaps include the superior gluteal artery flap, one of the most challenging reconstructive soft-tissue flaps to design for treatment of spinal wounds; the transpelvic rectus flap used to cover sacral and perineal wound defects; a transplanted latissimus free flap when a “reverse” latissimus flap is not reliable because of compromised segmental paraspinous arteries; and rarely, an omental flap to cover defects of the lower back.21

Outcomes

The use of vascular flaps has reduced the number of serial debridements required.24 Glassman et al.10 reported an adult series of serial debridements (mean 4.7 debridement procedures, range 2–10 procedures) and antibiotic beads provided instrumentation salvage, solid or probable fusion rates of 95%, and excellent long-term infection control. In another adult series in which debridement and flap closure was used, Vitz et al.24 report a mean of 1.4 operations (range 1–3 operations) in a cancer cohort and a mean of 1.2 operations (range 1–3 operations) in a degenerative disorder group; instrumentation removal was only performed in 1 patient (2.7%).

In our series of pediatric patients, there were 3 patients (Cases 1, 2, and 5) in which we exercised a technique of instrumentation removal, debridement, and flap closure. All required prolonged external orthosis wear and will likely require or required reinsertion of spinal instrumentation. Spinal instrumentation was retained in 2 patients without further sequelae.

Limitations of the Study

Only 5 of 128 patients overall developed this challenging complication, for an incidence of 3.9%. The small number of patients with this complication makes it difficult to draw any definitive conclusions. Future multinstitutional collaborative studies through spine organizations, such as the Pediatric Craniovascular Society and Scoliosis Research Society, may increase the number of patients enrolled in a study examining this complication and may allow more meaningful statistical analysis.

Because of the retrospective nature of this study, many of the variables recorded for the 5 patients with spinal instrumentation erosion through the skin were not recorded for the other 123 patients who did not develop this complication. We did not routinely obtain serum albumin level as a marker of nutrition status in our otherwise healthy patients. Therefore, we do not have a common set of variables to be able to compare and contrast between the 2 groups (those who developed instrumentation erosion, and those who did not). We may address this shortcoming in a subsequent prospective study.

Conclusions

Transpositional and advancement flaps appear to be efficacious and safe, making them a good option for the treatment of patients in whom wound complications develop after complex spine surgery in the pediatric age group. The patients where soft-tissue defects primarily occurred after spinal instrumentation were children with associated neuromuscular disorders or those with cancer. Removal of spinal instrumentation should be avoided to prevent subsequent instability. Vascularized soft-tissue coverage and prolonged antibiotics may eliminate dead space, and help eradicate contamination or infection. No functional deficits were associated with advancement or transposition flaps.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Jea. Acquisition of data: Jea, Vadivelu, Briceno. Analysis and interpretation of data: Jea, Vadivelu, Livingston, Ho, Izaddoost. Drafting the article: Jea, Vadivelu. Critically revising the article: Jea, Sayama, Vadivelu. Reviewed submitted version of manuscript: Jea, Sayama, Livingston, Ho, Izaddoost, Briceno, Luerssen. Approved the final version of the manuscript on behalf of all authors: Jea.

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Manuscript submitted December 13, 2013. Accepted August 18, 2014. Please include this information when citing this paper; published online September 26, 2014; DOI: 10.3171/2014.8.PEDS13664. Address correspondence to: Andrew Jea, M.D., Division of Pediatric Neurosurgery, Texas Children’s Hospital, 6621 Fannin St., CCC 1230.01, 12th Fl., Houston, TX 77030. email: ahjea@texaschildrens.com.