Spine fusion cross-link causing delayed dural erosion and CSF leak: case report

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The past 2 decades have seen a considerable increase in the number of lumbar spinal fusion surgeries. To enhance spinal stabilization and fusion, make the construct resistant to or stiffer for axial stress loading, lateral bending, and torsional stresses, cross-links and connectors were designed and included in a rod-screw construct. The authors present the case of a 49-year-old woman who presented 11 years after undergoing an L4–5 decompression and fusion in which a pedicle screw-rod construct with an integrated cross-link was designed to attach onto the pedicle screws. The patient's response at the time to the initial surgery was excellent; however, at the time of presentation 11 years later, she had significant postural headaches, severe neurogenic claudication, and radiculopathy. Imaging revealed canal compression across the instrumented levels and a possible thickened adherent filum terminale. Reexploration of the level revealed a large erosive dural defect with a CSF leak, spinal canal compression, and a thickened filum at the level of the cross-link. To the author's knowledge, such complications have not been reported in literature. The authors discuss this rare complication of spinal fusion and the need to avoid dural compression when cross-links are used.

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KEY WORDS spine fusion; instrumentation; cross-link; CSF leak; dural erosion

Case Report

A 49-year-old right-handed woman underwent a lumbar L4–5 discectomy and fusion with instrumentation at an outside hospital in 2002. She recovered well from her initial surgery and returned to her vigorous lifestyle that included activities such as walking and riding her bicycle. She presented in 2013, 11 years after her initial surgery, with progressively worsening low-back pain, which shot down her left lower-extremity, neurogenic claudication, and extremely limited mobility. Her pain scores on a visual analog scale (VAS) were 7/10 at baseline and 10/10 with activity. In addition, she complained of ill-defined headaches that were postural and would worsen on moving from the recumbent position to standing up. Her gait and activities were limited by the pain, and she denied having genitourinary symptoms. Conservative treatment included yoga, massage therapy, and more than 6 months of physical therapy. She had a poor response to local pain interventions that included blocks and epidural steroid injections and was taking daily opioid medication. On examination,
she had a body mass index of 34. Neurologically she had Grade 5/5 power in her lower extremities, normal reflexes, and no sensory deficits. Her straight leg-raising test was restricted on the left side, and there were no other evident neurological deficits.

She was evaluated with lumbar radiography and a CT myelography. The radiographs revealed pedicle screw-rod construct with a pseudarthrosis at L4–5. In addition there was a Grade 1 spondylolisthesis and loss of lumbar lordosis (Fig. 1). The terminal filum appeared to be thickened and tethered to the cross-link along with adhesive arachnoiditis in the L4–5 region, seen by clumping of the nerve roots in the region (Fig. 2). Intraoperatively we observed a pedicle screw-rod construct with an integrated low-lying transverse cross-link curving inwards into the spinal canal. There was a pseudarthrosis at the level of the L4–5 fusion. The cross-link was embedded in the spinal canal, causing significant dural compression, as predicted by the preoperative imaging studies (Fig. 3A). We noted a significant CSF leak as soon as we started to dissect and expose soft tissue around the construct, and a large dural rent was evident at the site where the cross-link was embedded (Fig. 3B). The underlying filum and nerve roots appeared to be impinged by the cross-link, when visualized through this dural defect (Fig. 3C). The construct was revised: We placed larger-diameter pedicle screws, and the thickened adherent filum was sectioned and released (Fig. 3D). Following the release of the filum, a duraplasty was performed using paraspinal muscle fascia to close the defect, suturing the fascial graft onto the adjacent dura (Fig. 3E). Postoperatively the patient’s low-back pain and radiculopathy significantly improved and no new postoperative neurological deficits occurred. She remained asymptomatic and without any evidence of a CSF leak at the 3-month follow-up. Her VAS score at baseline was 4 of 10 in the absence of any opioid medication, and she was able to gradually return to all her activities of daily living. At clinical evaluation at 11 months postoperatively her VAS score at baseline was 0–1 of 10 and, with activity, it varied from 1–3 of 10 without the use of any pain medication. Clinically she had no neurological deficits, had returned to work, and was near her preoperative activity levels. MRI was performed to evaluate any residual or persistent CSF leakage or filum tethering. T2-weighted imaging (Fig. 4A) 10 months following surgery did not reveal any evidence of filum tethering or a pseudomeningiocele, although there was a small residual fluid collection in the dead space adjacent to the fusion mass. To assess the completeness of arthrodesis across the L4–5 level, we performed CT scanning of the lumbar spine 11 months following her surgery. The CT scan (Fig. 4B) revealed a good bone fusion across the L4–5 levels.

**Discussion**

Procedure-related complications following placement of pedicle screw-rod constructs have been widely reported on in literature and include those related to the implanted hardware/device such as screw backout, screws breakage, and construct collapse. Other reported complications include incidental durotomy with CSF leaks, wound infections, hematomas, and possible neural injury with deficits. However, our case remains unique in the type of instrument-related complication. Pseudarthrosis and adjacent-
Complications of a spinal cross-link

Segment disease are expected complications over time, but dural erosion with CSF leak and an adherent terminal filum is not.

In our case the cross-link remains the direct cause and the literature provides no evidence for the use of cross-links in short-segment fusions. Cross-links were initially designed to improve and maintain coronal stability in long-segment scoliosis corrections. They may also prevent rod migration, improve axial stress loading, prevent lateral bending, and reduce the number of pedicle screws used in long-segment constructs. The factors affecting biomechanical analysis include the design of different cross-links, the biological model used for testing, and length of the construct. When cross-links were evaluated in the sagittal plane, no biomechanical difference in stability was identified in flexion-extension, although variable results were seen in lateral bending. There are no clear indications for the use of cross-links in short-segment lumbar spinal fusion surgery, but longer constructs in the thoracic and thoracolumbar segments may benefit from cross-links as the torsional load through the length of the rod can generate stresses causing loss of correction. The cross-links resist lateral displacement and improve pull-out strength of long transpedicular constructs, although a number of biomechanical studies evaluating the role of cross-links have reported variable results. The use of cross-links in short-segment lumbar fusions, hence, does not appear to be warranted in cases of spinal pathology in which excessive torsional forces across the construct would not be anticipated.

Cross-link design may also play an important role in the overall stiffness of the construct. Alizadeh et al. identified an X-type cross-link configuration that provided the greatest stability, reducing stress at the adjacent vertebral body and implant under various loading conditions in long-segment constructs; they found no benefit to the cross-link configuration in short-segment constructs. In our patient, the low-profile cross-link design, with the transverse connecting bar of the cross-link curved in toward the spinal canal, may have over time added to the dural erosion and filum scarring. The changes associated with degenerative spondylolisthesis, loss of lumbar lordotic curvature, and pseudarthrosis at L4–5, in conjunction with the inverted cross-link transverse bar, created an ideal environment for the dural erosion. Additionally, the spinal instability at L4–5 due to a pseudarthrosis and micromotion at the instrumented level caused intermittent tethering and inflammation of the filum resulting in its thickening. Along with this an adhesive arachnoiditis secondary to overcrowding of the cauda equina and constant micromotion secondary to the pseudarthrosis may have contributed to the recurrent pain and left lower-extremity radicular symptoms. We postulate a dynamic intermittent spinal stenosis at the L4–5 level with loading of the spine along with the filum tethering and arachnoiditis, resulting in the cross-links gradually eroding into the spinal dura over a period of many years. The defect was barely sealed off by the overlying soft tissue. In retrospect, possible intermittent CSF leaks when the patient stood erect may have been the cause of her headaches, with low pressure in concert with a possible ball-valve–like mechanism playing an important role.

Conclusions

A case of delayed dural erosion and CSF leakage sec-
Secondary to dural compression by a low-profile cross-link is reported. When cross-links are used, care must be taken to ensure the device is situated well away from the dura. There should be a heightened awareness for such rare complications. When this condition is encountered the treatment must include repair of the CSF leakage and more important, neural decompression and solidification of the fusion mass.

References


Author Contributions
Conception and design: both authors. Acquisition of data: Rahmathulla. Analysis and interpretation of data: both authors. Drafting the article: Rahmathulla. Critically revising the article: both authors. Reviewed submitted version of manuscript: both authors. Approved the final version of the manuscript on behalf of both authors: Rahmathulla. Administrative/technical/material support: Deen.

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