Chapter 6

Posterior Cervical Surgery Complications and Management, From Recent Literature

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Abstract

Posterior cervical approaches—including laminectomy, laminoplasty, posterior cervical fusion (PCF), and foraminotomy—are indispensable techniques for treating cervical myelopathy, radiculopathy, trauma, deformity, and tumors. Contemporary series and reviews report overall complication rates between approximately 10% and 30%, depending on patient comorbidity, procedure type, and fusion length, with higher rates in elderly, frail patients undergoing multilevel fusion. Acute neurological complications (most notably C5 palsy and spinal cord injury), infectious events, cerebrospinal fluid (CSF) leak, postoperative hematoma with airway compromise, pseudarthrosis, adjacent segment disease (ASD), and junctional kyphosis remain the main sources of morbidity.

This chapter synthesizes recent evidence (with emphasis on 2020–2023 literature) on the incidence, mechanisms, risk factors, prevention, and management of complications after posterior cervical surgery. We structure the discussion along a temporal axis—pre-operative risk stratification, intra-operative events, early postoperative complications, and late mechanical and alignment-related failures—and integrate anatomical considerations and surgical decision-making. Particular attention is given to the pathophysiology and management of C5 palsy, the role of intra-operative neuromonitoring (IONM) in preventing catastrophic cord injury, current concepts in surgical site infection (SSI) prevention, and strategies to mitigate pseudarthrosis and junctional problems in long posterior constructs. When combined with meticulous technique and protocolized perioperative care, these evidence-based strategies can substantially reduce complication rates and improve functional outcomes.

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1. INTRODUCTION AND OVERVIEW OF POSTERIOR CERVICAL APPROACHES

Posterior cervical surgery is a core strategy for the management of multilevel cervical spondylotic myelopathy, ossification of the posterior longitudinal ligament (OPLL), deformity correction, certain trauma patterns, and tumor resection. Laminectomy with or without fusion, laminoplasty, and instrumented PCF allow wide dorsal decompression of the spinal cord and address global sagittal alignment more effectively than short-segment anterior procedures in selected patients. [1,2]

Modern series indicate that posterior cervical procedures are effective but carry a distinct complication profile. In a focused review of posterior cervical decompression and fusion (PCF), Badiee et al. reported overall complication rates ranging from 15% to nearly 30%, with higher rates in multilevel constructs and in patients with significant frailty and medical comorbidity. [1] Lugo-Pico and Heller, in a 2022 narrative review, similarly summarized overall complication rates between 5.6% and 25% across diverse posterior cervical procedures, with C5 palsy, wound complications, and instrumentation-related problems among the most frequent surgery-specific events. [2]

This chapter provides a complication-oriented overview rather than a technique manual. The emphasis is on (1) mechanisms and risk factors, (2) evidence-based prevention and early recognition, and (3) practical management algorithms that can be embedded in day-to-day clinical pathways.

2. ACUTE NEUROLOGICAL COMPLICATIONS

2.1. C5 Nerve Root Palsy

Postoperative C5 palsy is the most characteristic neurological complication after posterior cervical decompression. It is classically defined as new or worsened deltoid (with or without biceps) weakness in the C5 myotome, with minimal sensory change, arising within days to weeks after surgery. [3] Incidence across mixed anterior and posterior series is typically 4–10%, with some posterior cohorts reporting rates up to 15%. [1–3,5]

A recent systematic review by Deshpande et al. highlighted several key features: most cases occur within one week postoperatively, the majority are unilateral, and approximately two-thirds of patients experience substantial or complete recovery within 6–12 months, while severe deficits (MRC ≤ 3/5) have a poorer prognosis. [3] Pennington et al. showed that the severity

of initial palsy is the strongest predictor of recovery time and likelihood of full recovery. [4]

The pathophysiology is multifactorial. Proposed mechanisms include:

- Posterior shift of the spinal cord after wide dorsal decompression, causing tethering and traction on a relatively short or stenotic C5 root.
- Direct or indirect root compression from foraminal stenosis, osteophytes, or tension from lordotic correction.
- Ischemic injury of the anterior horn cells or rootlets at the C4–5 level. [2,3]

Risk factors repeatedly identified include greater pre-operative canal stenosis, wider laminectomy and greater dorsal cord migration, pre-existing C4–5 foraminal narrowing, and more extensive lordotic correction in fusion constructs. [1–3]

Management and prevention

Most cases can be managed conservatively with analgesia, structured physiotherapy, and close neurological follow-up. [3,4] High-dose steroids are sometimes used empirically in the acute setting, although high-level evidence is lacking. Severe palsy or lack of meaningful recovery beyond 3–6 months may prompt imaging to assess for persistent foraminal compression and consideration of targeted C4–5 foraminotomy, but data supporting routine early revision are limited and mixed. [3,4]

Preventive measures supported by the literature include:

- Pre-operative assessment of C4–5 foramina, with prophylactic foraminotomy in selected high-risk cases. [1–3]
- Avoiding excessive posterior shift of the cord and over-correction of cervical lordosis. [1,2]
- Gentle handling around the C4–5 level and awareness of root tension when compressive lesions or deformity are corrected.

2.2. Spinal Cord Injury and Ischemia

Direct cord injury or peri-operative ischemia is rare but catastrophic, with reported rates typically <1–1.5% in modern series. [1,5] Mechanisms include direct mechanical compression or laceration, over-aggressive correction of deformity, epidural hematoma, and profound hypotension or malperfusion.

Multimodal intra-operative neuromonitoring (IONM) with somatosensory evoked potentials (SSEPs) and motor evoked potentials (MEPs) has become an important standard for high-risk cervical cases. Changes in MEPs, especially, are sensitive to anterior motor pathway compromise and should trigger immediate troubleshooting:

- Check and correct technical factors (electrodes, anesthetic depth, temperature).
- Restore mean arterial pressure (MAP ≥ 85–90 mmHg).
- Reverse recent corrective steps (rod rotation, compression/distraction maneuvers).
- Decompress any suspected residual stenosis or malpositioned hardware. [5]

If signals do not recover, aborting further correction, staging the procedure, or reversing implants may be necessary. Early postoperative imaging is mandatory in any unexpected neurological decline. [5]

3. EARLY POSTOPERATIVE WOUND AND SYSTEMIC COMPLICATIONS

3.1. Surgical Site Infection (SSI)

Posterior cervical fusion procedures, with long operative times and extensive soft-tissue dissection, carry a non-trivial SSI risk. Deep SSI rates after posterior cervical surgery in contemporary cohorts typically range from 2% to 5%, with higher rates in multilevel instrumented fusions, patients with high BMI, diabetes, smoking, and revision surgery. [1,2,6,7]

In a multicenter observational study limited to posterior cervical procedures, Ogihara et al. reported a 2.9% rate of deep SSI and identified high BMI, longer operative time, and greater numbers of fused levels as independent risk factors. [6] Broader registry analyses confirm the contribution of diabetes, malnutrition, and smoking to posterior cervical SSI risk. [7]

Prevention

Evidence-based SSI prevention strategies, aligned with CDC guidelines, include: [2,6–8]

- Pre-operative optimization of modifiable factors (glycemic control, smoking cessation, nutritional status).

- Weight-based first-generation cephalosporin within 60 minutes before incision; vancomycin reserved for MRSA colonization or β-lactam allergy. [8]
- Redosing intra-operatively for prolonged procedures and significant blood loss.
- Strict sterile technique with minimized operating room traffic, double-gloving with glove change before handling implants, and copious wound irrigation prior to closure. [2,6]
- Meticulous multilayer closure of fascia and subcutaneous tissues, with consideration of closed suction drains in high-risk patients.

Management

Superficial SSIs may respond to targeted antibiotics and local wound care. Deep SSIs or suspected implant infections require urgent imaging and early operative debridement, with multiple cultures, thorough irrigation, and prolonged intravenous antibiotics. [2,6,7] Hardware retention is sometimes possible in early postoperative infections when fixation is stable, but persistent or recurrent infection often necessitates hardware removal and staged reconstruction. [6,7]

3.2. Dural Tear, CSF Leak, and Pseudomeningocele

Incidental dural tears during cervical decompression are less frequent than in lumbar surgery but remain an important cause of postoperative CSF leak and pseudomeningocele. Reported dural tear rates across mixed cervical series range roughly from 1% to 4%, with higher risk in revision surgery, OPLL, and tumor resections. [2,5]

Intra-operative management consists of primary watertight dural closure whenever technically feasible, usually supplemented with sealants or onlay grafts. When primary closure is not possible (e.g., adherent dura in OPLL), patch grafts, sealants, and short-term CSF diversion (lumbar drain) may be considered. [2,5]

Postoperative leak or pseudomeningocele presents with wound swelling, persistent drainage of clear fluid, orthostatic headache, or rarely neurologic symptoms. Initial management includes head elevation, compressive dressings, and short-term lumbar CSF drainage. Persistent leaks, enlarging pseudomeningoceles, or any neurological deterioration warrant re-exploration and dural repair. [2,5]

3.3. Postoperative Hematoma and Airway Compromise

Postoperative hematoma in the posterior cervical compartment can compress the cord or nerve roots and, in rare cases, lead to airway compromise due to soft-tissue swelling. Although uncommon, this is a time-critical complication. [1,2]

Clinical warning signs include rapidly worsening neck pain, new neurological deficits, stridor, dysphagia, or respiratory distress. Management should not be delayed for imaging if there is hemodynamic or respiratory instability; reopening the wound at bedside or in the operating room to evacuate the hematoma and control bleeding may be lifesaving. If the airway is threatened, urgent intubation or surgical airway is prioritized. [1,2,5]

Perioperative control of blood pressure, careful hemostasis, and judicious postoperative anticoagulation management are key preventive steps.

4. LATE MECHANICAL AND ALIGNMENT-RELATED COMPLICATIONS

4.1. Pseudarthrosis (Non-union)

Failure of fusion (pseudarthrosis) is a fundamental late complication of posterior cervical fusion. Reported rates vary widely (5–20%) depending on fusion length, patient factors, graft choice, and radiographic criteria. [1,2,9,10]

Risk factors include smoking, multilevel constructs, poor bone quality (osteoporosis), chronic steroid use, malnutrition, and revision surgery. [1,2,9,10] Pseudarthrosis can both result from and contribute to hardware failure, loss of alignment, and recurrent pain.

Clinically significant pseudarthrosis typically manifests as persistent or recurrent axial neck pain, mechanical symptoms, or loss of correction on radiographs. Diagnosis is based on dynamic radiographs and, increasingly, CT to confirm lack of bridging bone across intended fusion levels. [9,10]

Management involves revision surgery with renewed decortication, more robust fixation, and augmentation with autograft and/or biologics. [9,10] Recently, there has been growing interest in patient-specific risk stratification to selectively use bone morphogenetic proteins or other osteoinductive agents in high-risk posterior cervical constructs, though concerns about cost and complications remain. [2,9]

4.2. Adjacent Segment Disease and Junctional Problems

Adjacent segment disease (ASD) and proximal/distal junctional kyphosis (PJK/DJK) are major sources of late morbidity after long posterior constructs. [1,2,11,12] Increased mechanical stresses at the ends of a rigid construct can accelerate degeneration or failure at adjacent segments.

ASD after PCF often presents with new radiculopathy or myelopathy at the motion segment just above or below the fusion. Both radiographic and clinical ASD have been reported, with 5–15% of patients developing symptomatic disease within 5–10 years in mixed anterior/posterior cervical cohorts. [1,2,12]

Distal junctional kyphosis after multilevel posterior cervical fusion has been highlighted in more recent work. Lee et al. described distal junctional kyphosis (DJK) as a loss of alignment distal to the instrumented segments, which can progress to mechanical failure or late neurological compromise. [11] Risk factors include pre-existing sagittal imbalance, inadequate restoration of cervical and cervicothoracic alignment, and constructs that terminate at high-stress transition levels (e.g., C7 instead of extending into the upper thoracic spine). [11,12]

Prevention strategies include:

- Careful pre-operative sagittal alignment analysis and planning to avoid over-correction or residual imbalance. [1,2,11]
- Considering extension of the construct into the upper thoracic spine in selected deformity or long-segment cases. [11,12]
- Soft tissue preservation and avoiding unnecessary disruption of posterior ligamentous structures at junctional levels.

Management of symptomatic ASD or junctional failure typically requires extension of the fusion, sometimes combined with osteotomies for sagittal realignment. [1,11,12]

4.3. Instrumentation Complications

Hardware-related complications include screw loosening, rod or screw fracture, malposition of lateral mass or pedicle screws with neural or vascular compromise, and prominence or irritation of implants. [1,2]

Malpositioned screws may cause radiculopathy, vertebral artery injury, or spinal cord compromise. Routine postoperative CT is not universally mandated but is recommended in deformity cases, high-risk trajectories, or when symptoms suggest hardware misplacement. [1,2]

Management ranges from observation for asymptomatic minor issues to urgent revision and decompression in the presence of neurological or vascular compromise. Addressing underlying non-union or imbalance is crucial to prevent recurrent hardware failures. [1,2,9]

5. RISK STRATIFICATION, PREVENTION ALGORITHMS, AND SYSTEMS OF CARE

5.1. Pre-operative Optimization

Recent work has underscored the importance of frailty, comorbidity burden, and modifiable risk factors in predicting complications after posterior cervical fusion. [1,2] High BMI, diabetes, smoking, chronic steroid use, and poor nutritional status all increase the risk of SSI, non-union, and medical complications. [1,2,6,7]

Pre-operative optimization should therefore include:

- Smoking cessation (ideally ≥ 4 weeks pre-operatively).
- Tight glycemic control and assessment of HbA1c.
- Correction of anemia and hypoalbuminemia where possible.
- Bone health evaluation in older patients or those with risk factors for osteoporosis, with pharmacologic treatment when indicated.

5.2. Intra-operative Strategy and Checklists

Drawing from the "bundle" experience in shunt and EVD surgery, [6–8] several groups have proposed standardized checklists and protocols for posterior cervical cases. Core elements include:

- Surgical time-outs that explicitly review levels, planned decompression and fusion extent, and neuromonitoring plan.
- Consistent antibiotic prophylaxis and redosing strategy. [8]
- IONM in high-risk cases, with pre-agreed thresholds for pausing or modifying the procedure when signals change. [5]
- Documentation of screw lengths, trajectories, and planned alignment targets.

Such systems-based approaches reduce variability and help teams respond promptly to early warning signs of complications.

5.3. Postoperative Surveillance and Follow-up

Early postoperative monitoring focuses on neurological examinations, wound status, respiratory function, and pain control. Protocolized checks for new weakness (especially deltoid strength), wound drainage, and swallowing or airway issues facilitate early detection of C5 palsy, hematoma, and infection. [1–3,5–7]

Long-term follow-up is essential to identify pseudarthrosis, ASD, and junctional problems. Standing radiographs and, when indicated, CT are used to assess fusion and alignment. Structured follow-up intervals (e.g., at 3, 6, and 12 months, then annually) combined with patient education regarding red-flag symptoms can improve the timeliness of revision when necessary. [1,2,9–12]

6. CONCLUSION

Posterior cervical surgery plays a central role in the management of multilevel cervical myelopathy, deformity, and complex pathology. Recent literature confirms that while neurological improvement and pain relief are achievable in the majority of patients, complication rates remain substantial, particularly in elderly, comorbid populations undergoing long multilevel fusions. [1,2] C5 palsy, wound infection, CSF leak, postoperative hematoma, pseudarthrosis, ASD, and junctional kyphosis are the principal procedure-specific sources of morbidity. [1–3,6,11,12]

Modern practice demands a systems-based approach: rigorous pre-operative risk stratification and optimization; meticulous technique and intra-operative neuromonitoring; evidence-based SSI prevention; and structured postoperative and long-term surveillance. When these elements are consistently applied, posterior cervical procedures can be performed with a high degree of safety and durability. Ongoing research into biomechanical risk factors, improved biomaterials, and patient-specific risk modeling will further refine complication prevention and management strategies in the coming years. [1–3,11,12]

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