



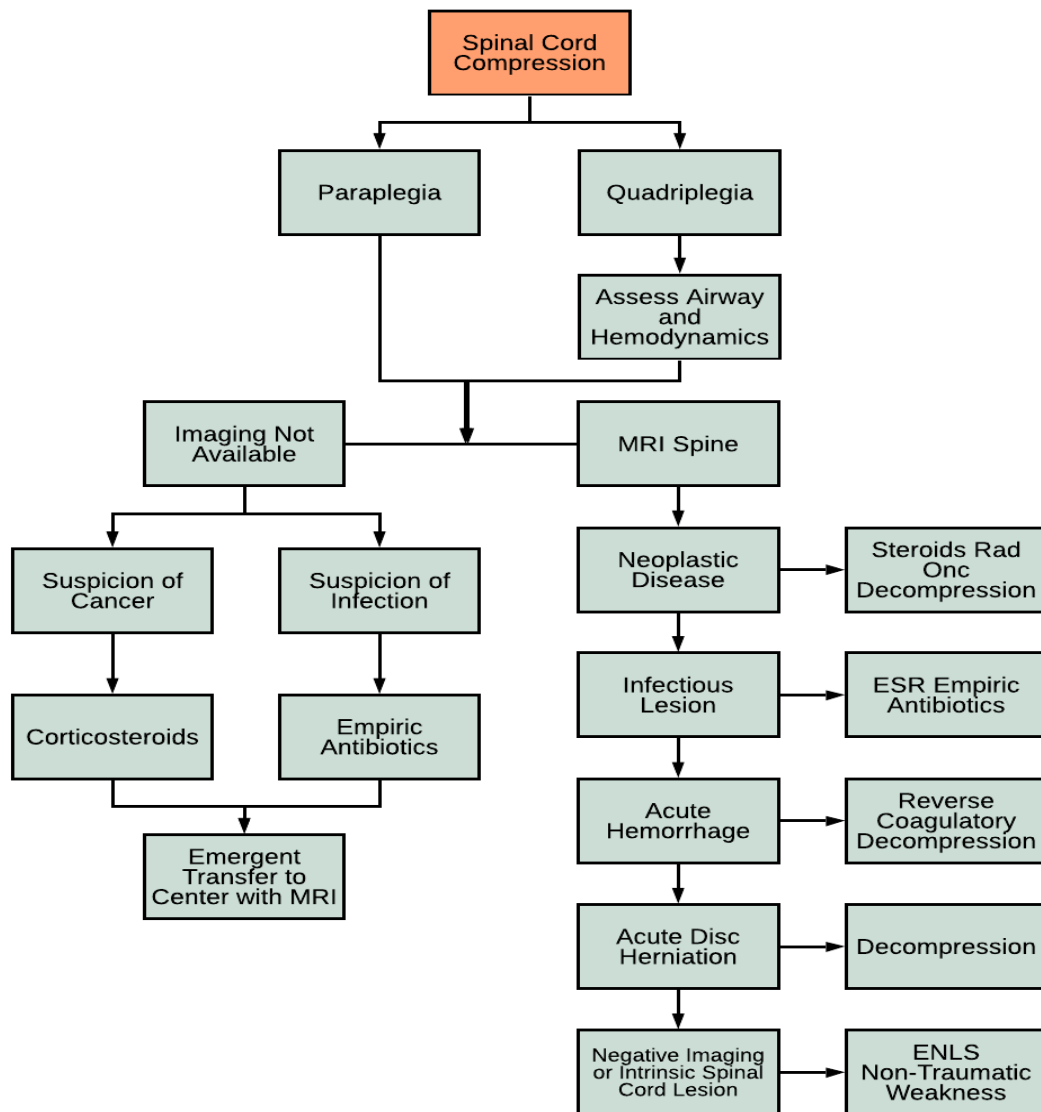
Emergency Neurological Life Support[®] Spinal Cord Compression Protocol Version 6.0

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SPINAL CORD COMPRESSION ALGORITHM



CLINICAL CHECKLIST

- Assess circulation/hemodynamics (fluids and vasopressors if needed)
- Assess airway/breathing (establish ventilation, especially in the setting of quadriplegia)
- Spinal motion restriction
- Brief history (evaluate for degenerative spinal disease, malignancy, coagulopathy, infections and trauma)
- Labs: complete blood count (CBC), Chemistries, prothrombin time (PT/INR), partial thromboplastin time (PTT), platelet function assay and thromboelastography
- Empiric treatment:
 - Suspected neoplastic disease: consider corticosteroids, contact radiation oncology and medical oncology
 - Suspected epidural infection: check erythrocyte sedimentation rate (ESR) and start antibiotics
 - Suspected spinal cord epidural hematoma: correct coagulopathy
- Obtain emergent spine imaging [magnetic resonance imaging (MRI) unless contraindicated or not available]
- Alert spine surgeon
- Supportive care: bladder decompression, intravenous (IV) access, hydration and analgesia
- Prepare communications checklist
- Initiate inter-facility transfer if needed

COMMUNICATION CHECKLIST

- Age, gender, premorbid conditions and risk factors
- Medical history (i.e., chronic back pain, cancer, IV drug abuse or immunosuppression)
- Onset and duration of symptoms
- Paraplegia or quadriplegia
- Spinal level of clinical involvement
- Vital signs
- Hemodynamic status
- Airway status
- Bowel or bladder involvement
- Results of lab tests
- Therapies initiated
- Discuss further interventions

DEGENERATIVE SPINE DISEASE / ACUTE DISC HERNIATION

Decompression

Degenerative spine disease with or without disc herniation is the most common cause of Spinal cord compression (SCC) and presents in the cervical and lumbar spine due to flexibility of these segments. Back pain is typically worse when standing/sitting and improved in the recumbent position. Spine MRI imaging is the diagnostic modality of choice. Surgical decompression has been shown to improve patient outcomes. Corticosteroids have uncertain therapeutic benefit but can be used to treat pain or as a bridge towards definitive surgical decompression.

If imaging reveals disc herniation or bone/osteophyte compression (spinal stenosis) of the spinal cord or cauda equina, this represents a neurosurgical emergency and requires emergent spinal surgeon consultation.

ACUTE HEMORRHAGE

Reverse coagulopathy and decompression

Spinal hematomas can present with rapidly developing paraparesis or quadriparesis with local or radicular pain. Spinal epidural hematomas are the more common compressive etiology, but intra-medullary hemorrhage (hematomyelia) and subdural hematoma from lumbar punctures can also occur and present similarly. The most common causes of non-traumatic spinal cord hematoma include coagulopathy, vascular malformations, inflammatory myelitis, spinal tumors, and syringomyelia. Traumatic causes include penetrating injuries and high-impact, blunt-force trauma, iatrogenic post-surgical bleeding or a late complication after radiotherapy.

MRI, with and without gadolinium, is the modality of choice for diagnosing spinal hematoma, as it will demonstrate both the hematoma and any associated underlying pathology, including spinal cord edema.

Treatment includes rapid reversal of coagulopathy and urgent evaluation for surgical decompression.

ASSESS HEMODYNAMICS AND AIRWAY

Cervical myelopathy may affect diaphragm

Spinal cord compression can cause hypotension (neurogenic) which may exacerbate spinal cord perfusion and induce secondary injury. Hemodynamic assessment should lead to urgent management of hypotension with normal blood pressure goals.

Patients with quadriplegia should be monitored closely for respiratory distress and failure.

- Frequent bedside pulmonary function testing and the detection of dysphonia and tachypnea are vital to diagnose impending respiratory collapse.
- Consider intubation if:
 - Forced vital capacity (FVC) < 1L or 20 mL/kg
 - Negative inspiratory force (NIF) < -30 cmH₂O
 - Inability to count to 10 during the single breath test
- The patient's own assessment of their respiratory status is frequently accurate but may be unreliable in the presence of analgesia or sedation.
- A low threshold should be maintained for placement of a definitive airway and mechanical ventilation, particularly if rapid progression of motor weakness is observed.

CORTICOSTEROIDS

Empirical treatment if cancer is suspected

Patients with malignant SCC and acute neurologic dysfunction should receive corticosteroids. Empirical treatment with corticosteroids is recommended in patients with known malignancy and acute SCC, even if unconfirmed by MRI spine imaging.

- Steroids are given to reduce edema and decrease the chance of spinal cord venous infarction. The use of steroids in patients with compression from epidural metastatic disease is considered to be part of standard medical therapy.
- Given the safety profile and efficacy of the lower dose of dexamethasone, we recommend a dexamethasone 10 mg IV loading dose followed by 4 mg oral/IV every 6 hours as maintenance.
- Equivalent doses of methylprednisolone can be used if dexamethasone is unavailable.

EMERGENT TRANSFER

To a facility that has spine imaging available

Due to the rapid progression of acute SCC syndromes, transfer agreements between emergency departments and acute care facilities should be pre-established to avoid prolonged attempts to find a facility when time is of the essence. Emergent transfer is warranted when the facility treating the SCC patient is unable to provide definitive care.

If emergent transfer is not feasible, or will be delayed significantly, then care should focus on spinal motion restriction, empirical treatment with corticosteroids or antibiotics (for the most likely diagnosis) and supportive care measures. The medical complications of spinal cord injury will need to be monitored and treated, including hemodynamic and respiratory instability, constipation, urinary retention, pain, deep vein thrombosis, and pressure ulcers.

To a facility that has pediatric specialists

Due to the unique etiologies of pediatric spinal cord compression and their treatments, transfer to an acute care center with pediatric specialists available should be arranged as quickly as possible. To prevent further injury, the spine should be immobilized and adequate perfusion and ventilation ensured prior to transport.

ANTIBIOTICS

Empirical treatment if infection is suspected

Patients with evidence of infection such as fever, leukocytosis, IV drug use, or a known infectious source should be started on empirical antibiotics after blood and urine cultures are drawn.

- Draw blood cultures and ESR
 - An ESR of less than 20 mm/h has excellent sensitivity for excluding a diagnosis of spinal epidural abscess

- Start empirical antibiotics with broad spectrum coverage
 - Abscesses are often multi-microbial
 - Methicillin-resistant *Staphylococcus aureus* (MRSA) coverage – start vancomycin
 - Gram-negative coverage – start third or fourth generation cephalosporin
 - Anaerobic coverage with metronidazole (should be considered in post-surgical and penetrating trauma)

IMAGING NOT AVAILABLE

No MRI or CT

Without imaging, consider empirical medical treatment until imaging can be obtained.

- If the history and clinical picture suggest infection and epidural abscess is a possibility, start empirical antibiotics.
- If there is a history of cancer and neoplastic spinal cord compression is a possibility, start empirical corticosteroids.
- Expedited transfer to a facility with imaging capability is necessary.

INFECTIOUS LESION

Empirical antibiotics and ESR

Suppurative infections of the spinal epidural space can cause neurological injury directly by compressing the spinal cord or indirectly by compromising blood flow. The classic triad of fever, back pain and neurologic dysfunction is not seen in most patients, and other symptoms may include localized back pain, radiculopathy, weakness, sensory changes and sphincter dysfunction.

- STAT consultation with a spine surgeon or facilitation of transfer if none is available.
- Draw blood cultures and ESR
 - An ESR of less than 20 has excellent sensitivity for excluding a diagnosis of spinal epidural abscess
- Start empirical antibiotics with broad spectrum coverage
 - Abscesses are often multi-microbial
 - MRSA coverage – start vancomycin
 - Gram-negative coverage – start third or fourth generation cephalosporin
 - Anaerobic coverage with metronidazole (should be considered in post-surgical and penetrating trauma)
- Antibiotics alone (without decompression) may be considered in patients who are either neurologically intact or who have had complete weakness for more than 48-72 hours.
 - In these patients, close observation for neurological worsening is advised given the high failure rates of medical management (6%-49%)

- Risk factors for neurological worsening
 - Diabetes
 - C-reactive protein > 115
 - White blood count > 12 $10^3/\mu\text{L}$
 - Age > 65
 - Positive blood cultures
 - MRSA infection
- In patients with neurological deficits, early decompression, irrigation and debridement is the mainstay of treatment.

MRI SPINE

Spine imaging is available

Emergent MRI with gadolinium is the imaging modality of choice.

- Computed tomography (CT) with contrast and or CT myelogram is an alternative if MRI is contraindicated or not available.

Imaging is used to rule out any compressive etiology of the spinal cord like tumor, infection or intervertebral disc herniation. It is important to communicate the neurological findings to your radiologist so that the proper location(s) of relevance is imaged.

- Quadriplegic patients should have at least the C-spine imaged. Entire spine imaging (including the conus) may also be appropriate especially if the patient has known cancer.
- Paraplegic patients (if there are no symptoms in the arms) should have thoracic and lumbosacral spine imaged.
- A discussion with the radiologist is important to image the proper level and to expedite imaging so that treatments can be provided efficiently.
- It is important to notify the surgeon early when evaluating a patient with myelopathy, so that they are aware of timing of spine imaging and the potential need for surgical decompression.

NEGATIVE IMAGING OR INTRINSIC SPINAL CORD LESION

ENLS Non-traumatic Weakness Protocol

Patients with acute symptoms of spinal cord dysfunction can have intrinsic or intra-medullary (non-compressive) abnormalities of the spinal cord on MRI. These include spinal infarct, inflammatory/demyelinating myelitis, infectious and para-infectious disease.

Spinal cord ischemia may require further imaging with spinal angiography to identify arteriovenous malformation, arterial occlusion or other vascular abnormalities. Serum and cerebrospinal fluid (CSF) studies should be sent for evidence of autoimmune and infectious vasculitis. Pediatric considerations: In children with diffuse or progressive weakness, differential diagnosis should include metabolic disorders and genetic etiologies such as spinal muscular atrophy. For infants < 1 year of age, infant botulism should be considered, particularly if cranial nerves are involved or there is significant constipation.

Negative spinal MRI in a patient with acute disturbance of motor and or sensory function (quadriplegia or paraplegia) should prompt evaluation for acute neuropathy, neuromuscular junction disorders and myopathy. Clinical presentation, CSF and electrophysiologic studies may establish a diagnosis of Guillain-Barré syndrome (acute polyradiculoneuropathy), Myasthenia Gravis, Lambert-Eaton syndrome, or motor neuron disease (see *ENLS Acute Non-Traumatic Weakness* protocol).

Spinal cord injury without radiographic abnormality (SCIWORA) is a clinical diagnosis made in the setting of trauma and spinal cord dysfunction without an MRI abnormality. The cervical spinal cord is most likely affected due to increased mobility of the cervical spine. Children are high risk for this injury due to the relatively large head-to-body ratio in childhood. Treatment is non-surgical due to the absence of a surgical lesion. Supportive measures include spinal motion restriction with collars, braces, or orthosis for up to 3 months. The use of corticosteroids in this setting should be carefully evaluated with inherent risks and used judiciously.

NEOPLASTIC DISEASE

Steroids, decompression, radiation oncology

Patients with malignant SCC and acute neurologic dysfunction should receive corticosteroids. Empirical treatment with corticosteroids is recommended when malignant SCC is suspected, even if unconfirmed by MRI spine imaging.

- Steroids are given to reduce edema and decrease the chance of spinal cord venous infarction. The use of steroids in patients with compression from epidural metastatic disease is considered part of standard medical therapy.
- Given the safety profile and efficacy of the lower dose of dexamethasone, we recommend a dexamethasone 10 mg IV loading dose followed by 4 mg oral/IV every 6 hours as maintenance.
- Equivalent doses of methylprednisolone can be used if dexamethasone is unavailable.

Once imaging and the diagnosis is confirmed, a combination of surgical treatment, radiotherapy, and chemotherapy is recommended. Surgical removal of tumor and spinal decompression is the primary and emergent treatment for malignant SCC.

- Early surgery (within 24 hours) with circumferential removal of the tumor, decompression of the spinal cord, and stabilization of the spine has been shown to significantly improve clinical outcomes (ambulation and pain), quality of life, and reduces need for narcotics and corticosteroids. It is also associated with a trend towards improved pain, quality of life and reduced need for analgesia.

Radiotherapy is used in conjunction with surgery and may be recommended alone in patients with minimal neurologic dysfunction and high degree of tumor responsiveness to radiation. Hematologic tumors such as lymphoma, myeloma, and seminoma are highly radiosensitive, while breast, lung and prostate have intermediate radiosensitivity. There have been significant advancements in radiosurgical techniques, and all malignant SCC patients should be referred for evaluation.

Chemotherapy is not a mainstay for acute treatment of malignant SCC and is always delivered in conjunction with radiotherapy and surgery.

PARAPLEGIA

Paraplegia is paralysis of the legs and lower body and is related to compression of the thoracic and/or lumbar spine.

Ventilatory issues are uncommon in patients with paraplegia/paraparesis, and transport and MRI imaging are safe.

QUADRIPLÉGIA

Special airway issues

Quadriplegia refers to weakness in all four extremities. In the event of sudden or progressive quadriplegia, the cause may be a cervical cord pathology. This may lead to hypoventilation because of both chest wall and diaphragmatic weakness, and respiratory assessment is vital before transport or MRI imaging.

SPINAL CORD COMPRESSION

Suspected myelopathy

The presentation of spinal cord compression includes:

- Back/neck pain
- Bilateral weakness or paralysis of the limbs
 - Paraplegia - just the legs
 - Quadriplegia - all four extremities
- Urinary retention
- Constipation or Obstipation
- Sensory level
 - Defined as a loss of sensation below the dermatomal level of compression
- Spinal shock
 - Defined as flaccid paralysis, loss of reflexes, and sensation below the level of compression
- Compression of the cauda equina can cause a similar clinical presentation with concomitant perineal (saddle) anesthesia and radicular pain
- Spinal cord compression at or above T4 can lead to hemodynamic instability secondary to loss of sympathetic tone
 - This leads to neurogenic shock with systemic hypotension and relative bradycardia

SCC of the cervical segments can lead to quadriplegia, whereas compression below these levels causes paraplegia, which is far more common. Quadriplegia is the most disabling presentation of SCC, and when present in an alert and responsive patient, should suggest a cervical spinal cord lesion. The most widely used severity scale is the American Spinal Injury Association Impairment Scale (ASIA) which was devised for traumatic SCC.

Immediately after recognition or suspicion for SCC, spinal motion restriction should be instituted with a cervical collar and thoracolumbar motion restriction if warranted. Spinal motion restriction and precautions during patient care (and transport) prevent further cord compression and injury. While optimal blood pressure is not known, spinal cord blood flow is often impaired in the setting of a compressive lesion, and hypotension should be avoided.