Acute Care SINS:

Surgical Insights for the Non-surgeon

Chapter 13: Spine Surgery SINS

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Summary

“Surgical Insights for the Non-surgeon,” or SINS, is composed of several short chapters intended to cover fundamental surgical knowledge for non-surgeons. The authors focus on surgical pearls, operative insights, and applied anatomy. In Chapter 13 of this series, the authors address the brain and neurosurgery Part Two.

Résumé

L'ouvrage « Surgical Insights for the Non-surgeon » (aperçu de la chirurgie à l'intention du non-chirurgien) se compose de courts chapitres couvrant les connaissances fondamentales en chirurgie. Les auteurs se concentrent sur des enseignements tirés de leur expérience, des aspects opératoires et l'anatomie appliquée. Dans le chapitre 13 de cet ouvrage, les auteurs abordent le cerveau et la deuxième partie de neurochirurgie.

“The definition of minor surgery: surgery which is done on someone else”
—Old surgical maxim . . . and a useful caution.

Anatomy

Although the spinal cord constitutes only about 2% of the central nervous system, it has a vital function: it connects the body to the brain and vice versa. Without it you would quite literally lose your head! Continuing from the medulla, the spinal cord extends from the foramen magnum and ends as the conus medullaris at the level of the first or second lumbar vertebra (Figure 1).

Below that, the nerves fan out like a horse's tail: appropriately termed the "cauda equina." Each nerve is composed of a ventral root containing efferent motor fibres and a dorsal root containing afferent sensory fibres. These combine in the spinal canal and pass through the vertebral column via the intervertebral foramina. There are 31 such paired spinal nerves: 8 cervical (C), 12 thoracic (T), 5 lumbar (L), 5 sacral (S), and 1 coccygeal nerve. Each spinal cord segment innervates a sensory dermatome (Figure 2) and a motor myotome. The spinal roots may also contain preganglionic sympathetic and parasympathetic fibres, depending on the level.

The spinal cord is a cylindrical tube 40–50 cm long and 1–1.5 cm in diameter. It has a cervical enlargement between C3–T1 providing innervation to the upper limbs; and a lumbar enlargement, between L1–S2, providing innervation to the lower limbs. The C1 nerve exits the spinal canal between C1 and the occiput of the skull; the C2–C7 nerves exit above their pedicles (for example, C5 exits between C4 and C5, above the pedicle of C5). Remember that there is no C8 vertebra.

Below the cervical spine, each nerve leaves the spinal canal below the pedicle of its corresponding vertebra. For example, the L4

nerve exits beneath the L4 pedicle. It follows that a typical posterolateral disc herniation in the cervical spine will affect the nerve root that corresponds to the vertebra below that disc space. For example, a C5/6 disc herniation affects the C6 nerve root (Figure 3). Similarly, in the lumbar spine, a typical L4/5 paracentral disc herniation will affect the L5 nerve root. The uncommon far lateral lumbar disc herniations affect the same-level nerve root: for example, a far lateral L4/5 herniation affects the L4 nerve.

In transverse section, the spinal cord has a central H-shaped area of grey matter which contains the cell bodies of the ventral (motor) horn and dorsal (sensory) horn. The white matter tracts surround the "H." These tracts include ascending sensory tracts, such as the posteriorly located dorsal columns, which are responsible for ipsilateral light touch and joint position sense. These tracts also include the spinothalamic tracts, which are responsible for contralateral pain and temperature. Laterally, the white matter contains the descending motor tract, called the corticospinal tract. This is responsible for ipsilateral limb movement. This tract crosses (decussates) in the medulla, which is why left brain injury affects the right body and vice versa.

The C1 vertebra, known as the atlas, has large lateral masses to allow head flexion and extension. The C2 vertebra, known as the axis, has a large anterior projection called the dens, or odontoid. This articulates closely with C1 to allow rotational head movement. Figure 3 shows a typical cervical vertebra below C2. Cervical vertebrae can be distinguished by their bifid spinous processes and the transverse foramina through which the vertebral arteries (C3–6) and veins (C3–7) pass. Figure 1 also shows shows a typical thoracic vertebra, and a typical lumbar vertebra. Thoracic vertebrae

Figure 1. Mid-sagittal section of the spinal cord and the bony spine column, with typical cervical, thoracic and lumbar vertebrae

are notable for their heart-shaped bodies and the costal facets that articulate with the ribs. The lumbar vertebrae are broader, have larger pedicles, and more horizontally oriented facet joints. Enough prose: it is time to match (anatomic) form with (spinal) function.

Figure 2. Map of dermatomes relating to cervical through to sacral nerve roots

Figure 3. Coronal view of the spinal cord demonstrating: A. Cervical nerve root compression (8 cervical nerves but 7 cervical vertebrae. Therefore, C6/7 disc herniation affects C7 nerve root, whilst T1/2 herniation affects T1 nerve root); B. Lumbar nerve root compression from a paracentral disc herniation (Paracentral disc herniations do not impinge on the nerve root exiting, but on the nerve root entering the lateral recess- which exits at the level below. Therefore, L4/5 disc affects L5 nerve root); C. Far lateral disc herniation (therefore L4/5 disc affects L4 nerve root)

Trauma

Spine Fractures

Cervical spine (C-spine)

- Separated into atlanto-axial (C1–2) fractures and sub-axial fractures (C3–C7)
- Need to determine:
 - Mechanism of injury
 - Strong association between head injury and C-spine injury
 - A high index of suspicion is required after polytrauma (for example motor-vehicle injuries, or falls from height)
 - Neurologic status (spinal cord and nerve root function)
 - Presence/absence of disruption to the discoligamentous complex
- Incomplete spinal cord injury has much better prognosis than complete injury
- Non-operative management means fracture reduction and immobilization
 - Reduction, if required, equals traction with a halo ring, provided the patient can participate in serial assessments of their neurologic status
 - Once the halo is secured to the skull
 - Weight is added using a traction system
 - General rule is 5 lbs for the head
 - Plus 2.5 lbs for each cervical spine level above the fracture
 - Before adding additional weight:
 - Confirm no change in the neurologic exam
 - Review a lateral X-ray to check for reduction vs. over-distraction
 - Once reduction is achieved, some patients can be immobilized using the halo-vest attachment
- Indications for operative reduction and stabilization include:
 - Failure of non-operative management
 - Fractures deemed unstable
 - Surgery may also be required to decompress the nerve roots or the spinal cord (i.e. the neural elements)
- Common C-spine fractures
 - Jefferson's: fracture of anterior and posterior arches of C1
 - Axial compression or hyperextension
 - Lateral displacement of C1's lateral masses
 - Often unstable
 - Hangman's: fracture of both pedicles of C2
 - Neck hyperextension
 - Type I: pedicles only
 - Type II: also into the body of C2
 - Type III: includes facet dislocation; unstable
 - Clay Shoveler's: spinous process fracture of C6, C7, or T1
 - Hyperflexion of neck; avulsion of the spinous process
 - Odontoid fractures: fracture of the dens of C2
 - Type I in the upper odontoid
 - Rare, but potentially unstable

- Type II in the base of the odontoid
 - Unstable and with a high risk of non-union
- Type III through the odontoid and into the body of C2
 - Most likely to heal due to this fracture's large surface area

Thoracolumbar (TL) Spine

- Principles of TL surgery
 - Fracture reduction if necessary (open or closed)
 - Decompression if there is compromise of neural elements
 - Certain fractures are amenable to non-operative stabilization
 - Surgical fusion for instability and failed non-operative stabilization
- Fractures are considered unstable if more than two of three columns are affected
 - Anterior column includes the anterior longitudinal ligament and anterior two-thirds of the vertebral body
 - Middle column contains the posterior longitudinal ligament and posterior one-third of the vertebral body
 - Posterior column contains the pedicles, facets, laminae, and spinous processes

'Clearing' the Spine

- To fully clear the spine
 - Attend to both the radiological and clinical components
 - Must be no radiographic evidence of bony or ligamentous disruption
 - Must be no clinical evidence of spinal cord or nerve root injury
- Spine precautions
 - Cervical collar, flat patient, and bed rest/log-roll
 - Maintain until the spine is cleared
 - Back board is not necessary
 - Should be removed on Emergency Department arrival
 - Because it predisposes to the development of sacral ulcers
- Radiographic clearance
 - In awake and cooperative patient with no distracting injury, complete and adequate plain X-rays (seeing down to C7–T1 and including flexion/extension views) are adequate for c-spine clearance
 - However, CT scan is the gold standard when looking for spinal fractures
 - Also, CT is required to
 - Better elucidate fractures seen on X-ray
 - When the X-rays are inadequate or incomplete
 - Or when there is a high index of suspicion of severe injury
 - Evidence of ligamentous disruption may be picked up by CT
 - Widening of the facet joints

- Disc space narrowing or widening
 - MRI if there is remaining doubt
- Therefore, CT is required in most trauma
- MRI can identify any spinal cord compression or injury, and can assess ligamentous injury
 - BUT can be avoided
 - If no concern of bony/ligamentous disruption
 - If the patient is clinically intact
- Clinical clearance
 - Patient must be awake, able to follow commands, free of distracting injuries
 - Full neurological exam should be done
 - This includes motor and sensory function
 - Includes both the upper and lower extremities
 - Includes rectal tone/sensation
 - "If you don't put your finger in it; you'll put your foot in it" (old surgical [and medical]) maxim
 - Any physician is capable of clinically clearing the spine
 - Consultation with spine surgeon not always required
 - But appropriate for those with documented/highly suspected spine fracture or neurologic injury

Spinal Cord Injury (SCI)

Definitions

- Level of injury
 - Described as being the most caudal spinal cord segment with motor function at least 3/5
 - Also with pain and temperature sensation preserved
 - For example, quadriplegia with preserved bicep function is called a C5 injury
- Incomplete injury
 - Residual motor or sensory function four or more segments below the level of injury
- Complete injury
 - No motor or sensory function four or more segments below the level of injury
- Neurogenic shock
 - Hypotension/hypoperfusion following spinal cord or brain injury
 - Loss of vascular tone due to disrupted sympathetics
 - In spinal cord injury, involves the cervical or high thoracic cord
 - At or above the level where the vascular sympathetics leave the spinal cord (T1–T12)
 - Unopposed activity from the cardiac parasympathetics (vagal nerve)
 - Causes an inappropriate bradycardia
 - Loss of muscle tone from skeletal paralysis below the level of injury
 - Causes decreased venous return
 - Further exacerbates hypotension
- Spinal shock

- NOT the same thing as neurogenic shock
- Transient loss of all neurologic function (voluntary and reflex) below level of injury
- Flaccid paralysis and areflexia
 - Lasts 1–2 weeks
- Probably due to potassium loss in injured cells
 - Extracellular potassium accumulation and axonal inhibition
 - Once potassium equilibrates, spinal shock ceases
- Paralysis may persist after spinal shock resolves
 - But with the emergence of upper motor neuron signs
 - Spasticity and hyper-reflexia
- Bulbocavernosus (BC) reflex
 - Typically one of first reflexes to return after spinal shock
 - Absence of motor and sensation BUT presence of BC reflex
 - Indicates complete spinal cord injury
 - Namely, loss of function is no longer due to spinal shock
- Bilateral motor paralysis below level of injury
- Painful dysesthesia in the upper extremities
- Bilateral loss of pain and temperature (spinothalamic tract)
- Sparing of two-point discrimination, vibration and proprioception
 - This would imply preservation of the dorsal columns
- Brown-Séquard syndrome
 - Results from spinal cord hemi-section
 - Rarely a traumatic injury, but could occur in penetrating trauma
 - Can also follow a large space-occupying lesion or focal demyelination
 - Including paracentral disc herniation
 - Ipsilateral loss of motor function below the level (corticospinal tract)
 - Ipsilateral loss of proprioception/vibration (dorsal columns)
 - Contralateral loss of pain and temperature (spinothalamic tract)
 - Preserved light-touch due to representation in both spinothalamic tracts (crude touch) and dorsal columns (fine touch)

Incomplete SCI Syndromes

- Central cord syndrome
 - Most common syndrome
 - Classically follows acute neck hyperextension injury in an elderly patient
 - Patient typically has pre-existing spinal canal stenosis
 - Central portion of cord is a watershed zone
 - Most susceptible to injury from edema caused by transient compression
 - Weakness of upper extremities with lesser effect on lower extremities
 - Reverse of what you would expect in other SCI
 - Injury pattern is because cervical fibres run more medially within the corticospinal (i.e. motor) tracts
- Anterior cord syndrome
 - Occlusion of the anterior spinal artery
 - Results in cord infarction in the distribution of this vessel
 - i.e. the anterior two-thirds of the cord

Acute Management of SCI

- Initial stabilization of the airway, breathing, and circulation
 - Do not forget your ABCs
 - See Trauma SINS chapter
- Spinal cord decompression may be indicated
 - Reduction and operative decompression
 - Urgent in cases of incomplete injury
- Management of bony or ligamentous injury
 - As outlined above
- Maintain mean arterial pressure (MAP) ≥ 85 mmHg for 7 days post-injury
 - To maintain adequate spinal cord perfusion
 - To give greatest chance of recovery in ischemic but not infarcted cord
 - Also known as the “spinal penumbra”
- Steroid treatment of SCI is no longer recommended

Table 1. ASIA Impairment Scale

- Classification system for SCI
- Based on the American Spinal Injury Association (ASIA) motor scoring system

Class A	Complete: no motor or sensory function below neurologic level
Class B	Incomplete: sensory but no motor function below neurologic level
Class C	Incomplete: motor function below neurological level, with more than half of key muscle groups below with strength < 3
Class D	Incomplete: motor function preserved below neurological level, with more than half of key muscle groups below having strength ≥ 3
Class E	Normal – sensory and motor function normal

- ASIA assessment (see Table 1) should be completed at admission and at 48 hours
 - This aids with prognostication
- In patients with paralysis:
 - Deep vein thrombosis (DVT) prophylaxis with low molecular weight heparin +/- pneumatic compression stockings
 - DVT/pulmonary embolus (PE) is a leading cause of morbidity/mortality in SCI patients
- Frequent repositioning and pneumatic beds
 - To minimize the development of pressure ulcers
- Bladder catheterization will likely be necessary as retention is common
 - And overflow incontinence can further predispose to sacral ulcers
 - Indwelling catheter initially, then in-and-out catheterization if bladder does not recover
- May have initial bowel incontinence with need for rectal catheterization for hygiene
 - Later constipation becomes an issue, requiring aggressive bowel regimens
- Once the spine is stabilized
 - The focus moves to aggressive physiotherapy, occupational therapy assessments, and long-term spine rehabilitation

Degenerative Spine Disease

Mechanical Back Pain

- Very common: lifetime prevalence as high as 90%
- Also one of the most common causes of disability in young persons
- Multifactorial etiology:
 - Combination of degenerative disc disease, facet joint sclerosis/osteoarthritis, and muscular/ligamentous strain
- For most, conservative management suffices
 - Over the counter pain or anti-inflammatory medications
 - Plus core-strengthening exercise/return to normal activities after a very brief period of rest
- Further workup in the setting of “red flags”
 - Cancer: age > 50 yrs, history of cancer, unexplained weight loss
 - Compression fracture: advanced age (> 70), trauma, history of osteoporosis, steroid use, substance abuse
 - Infection: fever/chills, recent infection, immunosuppression, use of intravenous drugs
- Consultation to a spine surgeon is not indicated for isolated acute or chronic low back pain without radicular or other neurologic symptoms/signs
 - Because there are no surgical solutions to this
 - Spondylolisthesis may be an exception
 - Spondylolisthesis

- Definition: where one vertebral body slips forward on another
 - Can be fixed or dynamic
 - Back pain from dynamic spondylolisthesis may improve with spinal fusion

Radiculopathy

Pathophysiology

- By definition, this means pathology of the nerve root
- Most commonly caused by compression of a single nerve root by a disc herniation
- Radiculopathy can involve both motor and sensory components of the nerve root
 - Loss of muscle bulk, weakness
 - Decreased sensation in distribution of affected nerve root
 - Diminished or absent relevant reflex
- Compression can also result from neoplastic or infectious processes
- Could also be non-compressive
 - i.e. inflammatory or metabolic

Presentation

- Most common radiculopathies: C5, C6, C7 (neck); L5, S1 (lower back)
- Symptoms include pain (most common), numbness, weakness in distribution of the affected nerve root

Evaluation

- Always perform a thorough neurologic examination
 - Looking at motor, sensory, and reflexes from the affected nerve root
 - Look for other potential causes of the neurologic presentation
 - Elevated reflexes or involvement of both the upper and lower extremity suggests myelopathy
 - Multifocal changes may suggest an inflammatory/metabolic problem
- In the upper extremity, patients may have a positive Spurling test
 - Flex the head laterally towards the affected side
 - If painful, then test is positive (and over)
 - If no pain, then the physician applies further pressure (laterally and downwards) to the top of the patient's head
 - Pain radiates in the direction of the corresponding dermatome
- In the lower extremity, straight leg raise test may be positive
 - Supine patient; flex the extended leg at the hip (done by MD not patient)
 - Look for radiating pain towards the L5 or S1 dermatomes
 - Record the angle at which pain is elicited

- Confirmed with a cross-leg straight raise
 - Lift the non-affected leg; expect pain in the affected leg

Management

- Natural history of acute disc herniation-related radiculopathy:
 - Spontaneous improvement occurs in 80–90% of patients
 - Generally within 3–6 months (cervical radiculopathies often take longer than lumbar radiculopathies to recover)
- Analgesia
 - Over the counter pain and anti-inflammatory medications for most
 - Narcotics tend to be less effective; if used, very short term (days) only
 - Medication targeting neuropathic pain may be added
 - e.g. pregabalin, gabapentin, or nortriptyline (helps with sleep)
- Nerve root blocks
 - Local anaesthetic and/or steroid injections
 - An option for short-term relief
 - No proven long-term benefit
 - Can also aid in identifying the spinal level responsible for symptoms
- Significant radicular pain that persists
 - Imaging studies are indicated
 - CT scans can demonstrate disc pathology
 - However, MRI is the preferred test for diagnosis and surgical planning
- Nerve conduction studies
 - May help isolate the affected nerve root in unclear cases
 - Or distinguish active radiculopathy from chronic changes
- Surgery is indicated for patients:
 - Who fail to respond to conservative management
 - For progressive or severe motor deficit
 - For bowel or bladder involvement (cauda equina syndrome)
 - Microscope-assisted discectomy is the most common procedure in the lumbar spine
- Cervical spine disc herniations most commonly treated with anterior cervical decompression and fusion
- Posterior foraminotomy is also used in selected cases

Myelopathy

Pathophysiology

- Clinical syndrome manifesting as spinal cord dysfunction
- Can be the result of compression
 - Chronic degenerative changes (cervical stenosis), acute central disc herniation, neoplastic, infectious process, etc.
- Can be the result of intrinsic pathology
 - Syringomyelia, neoplastic process, inflammatory lesions (multiple sclerosis)

- May involve the cervical, thoracic, and upper lumbar regions of the spinal cord
 - Remembering that the cord ends at the L1/L2 level

Presentation

- Upper motor neuron findings
 - Spasticity, increased tone, hyperreflexia, clonus
- Patients most often first notice problems with their gait
- In cervical myelopathy, increasing difficulty with fine motor movements in the hands
 - Difficulty with handwriting, buttons/zippers, unable to manipulate objects

Evaluation

- Hyperreflexia on examination
 - Upper extremities: bilateral Hoffman's
 - Lower extremities: bilateral Babinski's
- Non-dermatomal sensory loss: look for sensory level
- MRI identifies the source of myelopathy and the extent of cord injury
- Severe cord compression causes MRI signal change in the spinal cord
 - Hyperintensity on an unenhanced T2 MRI image
- Remainder of work-up dictated by the presumed etiology of the myelopathy

Management

- Typically, compressive myelopathy needs surgical decompression and fusion in selected cases

Cauda Equina Syndrome (CES)

Pathophysiology

- Usually secondary to a large acute lumbar disc herniation
- Large herniation can compress the entire cauda equina
- Results in a combination of bilateral motor and sensory symptoms
- Results in bowel and bladder dysfunction
- If not a disc, often a cancerous tumour, both primary and metastatic

Presentation

- Signs and symptoms usually bilateral
- Acute presentation is severe back pain
 - +/- Radicular pain, often down back of legs
 - Or worsening of pre-existing back/radicular pain
- Motor weakness
 - Often involves more than a single nerve root; can progress to paraplegia
- Saddle anesthesia (numbness in the perineal region)
 - A very concerning sign
 - The result of compression of the sacral nerve roots
- Urinary retention

- From compression of parasympathetics running in nerve roots S2–S4
- Results in an atonic bladder and unopposed sphincter tone
- Caution: pain alone is common cause of urinary retention
- Patients can also experience urinary incontinence
 - Due to overflow and leakage from a distended bladder
 - Needs to be distinguished from urge or stress incontinence
 - Voluntary retention and associated overflow can occur when there is profound dysuria
 - Overflow secondary to cauda equina syndrome typically has associated painless retention
- Fecal incontinence can occur secondary to loss of rectal tone

Evaluation

- A thorough neurologic exam of the lower extremities plus rectal tone/sensation
- A post-void residual should be obtained
 - Either by in-and-out catheterization or bladder scan after the patient has voided
 - Any post-void volume over 100 mL is abnormal and supports the diagnosis
 - However, patients in pain, elderly, multiparous women, and elderly men with urinary retention from prostatic hypertrophy can have high residuals
- If the exam supports CES
 - MRI is needed to confirm and to identify the level of compression
 - CT is less useful
 - As the disc is not well-seen in this modality

Management

- CES is a surgical emergency!
 - Urgent decompression to avoid irreversible paraplegia
 - And loss of bowel/bladder/sexual function
- Discectomy is performed to remove herniated disc material
- Wider laminectomy may be required for surgical access
 - Many patients can recover, provided there is timely intervention
 - Unfortunately, long-term bladder and sexual dysfunction can occur

Lumbar Spinal Stenosis

Pathophysiology

- Usually from hypertrophy of facet joints and spinal ligaments
- Often underlying degenerative disc disease
 - Degenerative changes are more likely to become symptomatic when superimposed on a congenitally narrowed canal

Presentation

- Most common presenting symptom is neurogenic claudication
- Progressive low back/posterior thigh pain that occurs with standing or walking
 - When severe- and in contrast to vascular claudication- patients experience pain immediately on standing upright and pain is relieved quickly by sitting
 - Walking in a flexed position, such as leaning on a shopping cart, can increase a patient's range
 - Differentiate from vascular claudication
 - WHICH IS also brought on by activity and relieved by rest
 - BUT is independent of position
 - AND stopping to stand alleviates vascular claudication; sitting is not necessary
 - Associated with trophic changes and diminished or absent pedal pulses seen in peripheral vascular disease

Evaluation

- Decreased reflexes and positional pain (especially with back extension) are not uncommon
- BUT exam may be normal

Management

- Non-surgical treatment is preferred
 - NSAIDs/acetaminophen and physiotherapy
- MRI is the pre-surgical test of choice
 - Demonstrates canal stenosis and compression of neural structures
- Surgery is indicated for patients who have severe impairment despite a trial of conservative management
 - Most cases can be treated with a simple decompressive laminectomy
 - Fusion may be indicated if there is associated instability

Surgical Pearl #1

Lumbar Puncture

Indications

- Presumed infection (bacterial; viral; fungal)
- Guillain Barré (increased protein but not increased WBCs)
- Multiple Sclerosis (oligoclonal bands)
- Subarachnoid hemorrhage (red blood cells/xanthochromia in CT negative thunderclap headache)
- Leptomenigeal carcinomatosis (abnormal cytology)

Contraindications

- Signs of cerebral herniation
- Signs of raised intracranial pressure
 - With focal deficit or known space-occupying lesion
- Cardiorespiratory compromise preventing appropriate positioning
- Coagulopathy (risk of spinal epidural hematoma)
- Infection at the site of insertion
- Spina bifida may represent a relative contraindication, as tethering of the spinal cord may be present

Procedure

1. Position the patient
 - Either sitting up, or in lateral decubitus
 - Back flexed, knees tucked in toward chest, chin on chest
 - Approximate the L4/L5 space
 - Midline at the height of the superior iliac spines
 - Palpate the space between spinous processes
2. Under sterile conditions and after local anesthetic
 - Insert spinal needle between spinous processes
 - Typically spinal needles are 20 gauge or smaller
 - To minimize the risk of dural puncture headache
 - Larger needles may be used for specific indications
 - i.e. to measure CSF pressure
 - Angle superiorly ~ 15–30 degrees, with the bevel of the needle parallel to the sagittal plane (aim toward the umbilicus)
 - Advance through subcutaneous tissue and ligamentum flavum
 - Feel “pop” as needle goes through dura
 - Periodically withdraw the stylet to observe for CSF flow
3. Once CSF is obtained
 - Withdraw the needle and place a sterile bandage
 - In certain cases an opening pressure may be recorded as an approximation of intracranial pressure (supine position only)

Surgical Pearl #2

Lumbar Drain Insertion

Common Indications

- Relief of pressure in the setting of CSF leak after surgery
 - In order to facilitate dural healing
- If multiple diagnostic or therapeutic LPs required
 - A lumbar drain can minimize patient discomfort
- Prophylactically
 - To reduce ICP by drainage of CSF during some intracranial procedures

Procedure

1. Same as for lumbar puncture
2. In addition
 - Insert Tuohy needle with bevel parallel to sagittal plane
 - Access the thecal sac
 - Then rotate the bevel toward the head
 - Be careful to avoid too much CSF drainage once the stylet is removed
3. Thread lumbar drain catheter through Tuohy needle
 - To approximately the 15-cm mark (but can vary, depending on the depth of needle penetration required)
4. Remove the needle over the catheter
 - Cap the catheter
 - Securing the cap in place with a silk tie or suture
 - Be careful to avoid withdrawing or cutting the catheter while removing needle
5. Secure the drain in place and connect to drain collection system
 - Observe for flow of CSF

Surgical Pearl #3

Halo Vest (to be performed by neurosurgical or orthopedic service)

Common Indication

- Immobilization of cervical spine fractures/dislocations, provided there is satisfactory reduction

Contraindications

- Skull defects or fracture at the pin sites
- Infection at the pin sites
- Congenital bone defects
- Children aged under 3 years
- Elderly patients with bone demineralization
- Movement disorders where pin erosion is likely to occur

Procedure

1. Shave and sterilize the pin sites on the skull
2. Inject local anesthetic into the pin sites (anesthetize down to bone)
3. Position the ring just below the widest part of the skull: approximately mid-forehead, 1 cm above orbital bar and 1 cm above pinna
4. Hold the ring in place temporarily with the suction cups as you advance the pins and screw them into the skull
5. Insert anterior pins above the lateral orbit to ensure that the frontal sinus, supra-trochlear, and supra-orbital nerves are not injured; ensure patients eyes are closed to avoid pinning eyes opened
6. Insert posterior pins just behind the pinna, avoiding mastoid air cells
7. Tighten the pins sequentially, opposite one another; use torque wrench to ensure complete tightening
8. Attach halo ring to the vest for stabilization
9. Re-torque the pins on the following day and ensure they are cleaned regularly

Surgical Pearl #4

Cervical Spine Traction (to be performed by neurosurgical or orthopedic service)

Common Indications

- Reduction of fractures/dislocations
- Decompression of spinal cord/nerve roots

Contraindications

- Atlanto-occipital dislocation, type IIA and III hangman's fractures
- A separate rostral lesion (higher in the cervical spine)
- Skull defects or fracture at the pin sites
- Infection at the pin sites
- Congenital bone defects, children aged under 3 years, elderly patients with bone demineralization, or movement disorders where pin erosion is likely to occur
- Obtunded patient unable to notify clinician of new deficits during reduction

Procedure

1. Attach halo ring as previously outlined
2. Apply traction to reduce fracture: typically 5 lbs for the head, then 2.5 lbs for each spinal level above the fracture
3. Obtain a C-spine X-ray a half-hour after traction to check for reduction
4. Add more weight as necessary until reduction is achieved or if over-distraction is demonstrated (widening of the disc spaces)
5. Must stop if any new neurologic deficits occur
6. Once fracture is reduced, can decrease some of the weight to avoid over-distraction and maintain alignment