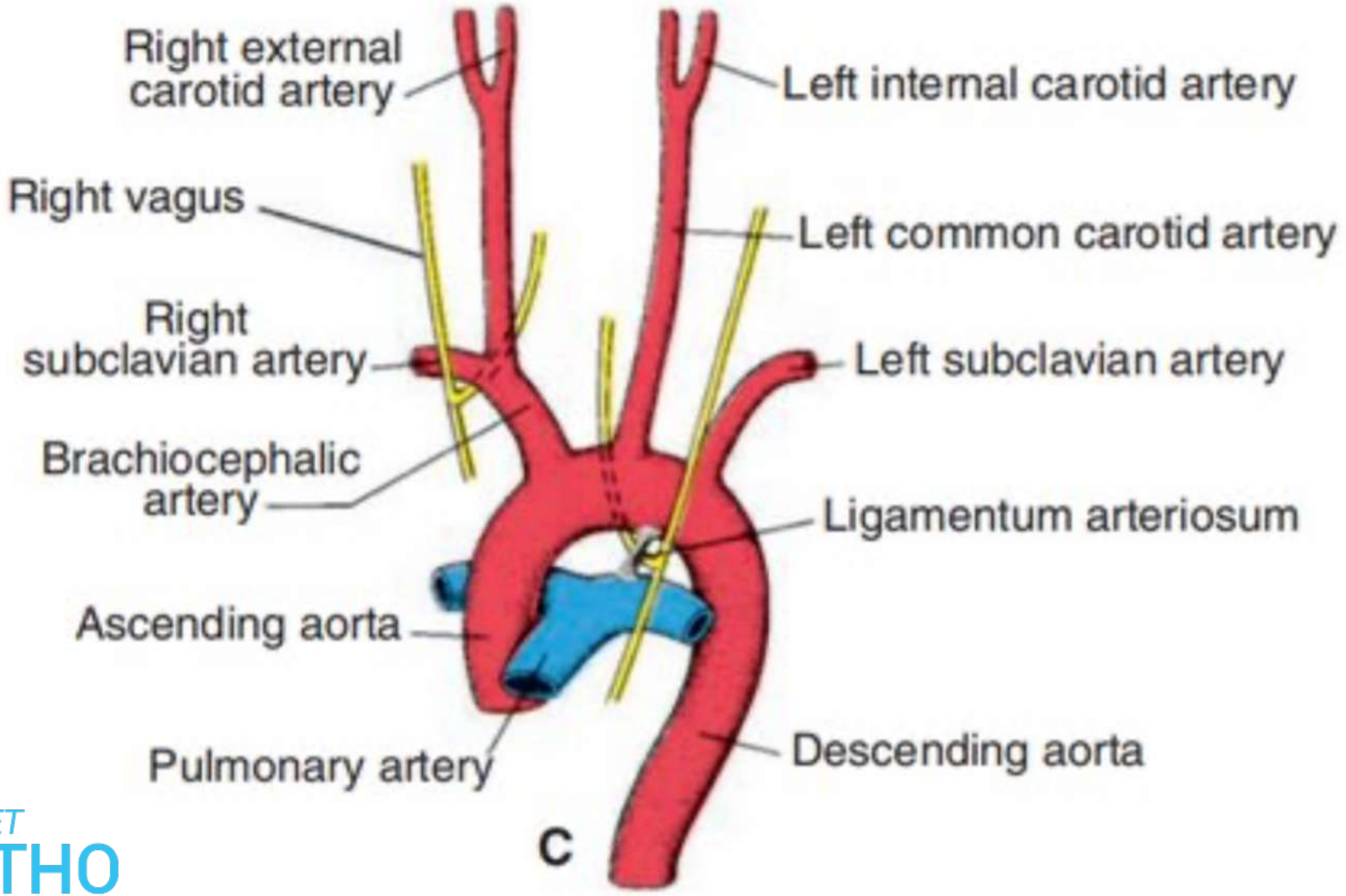
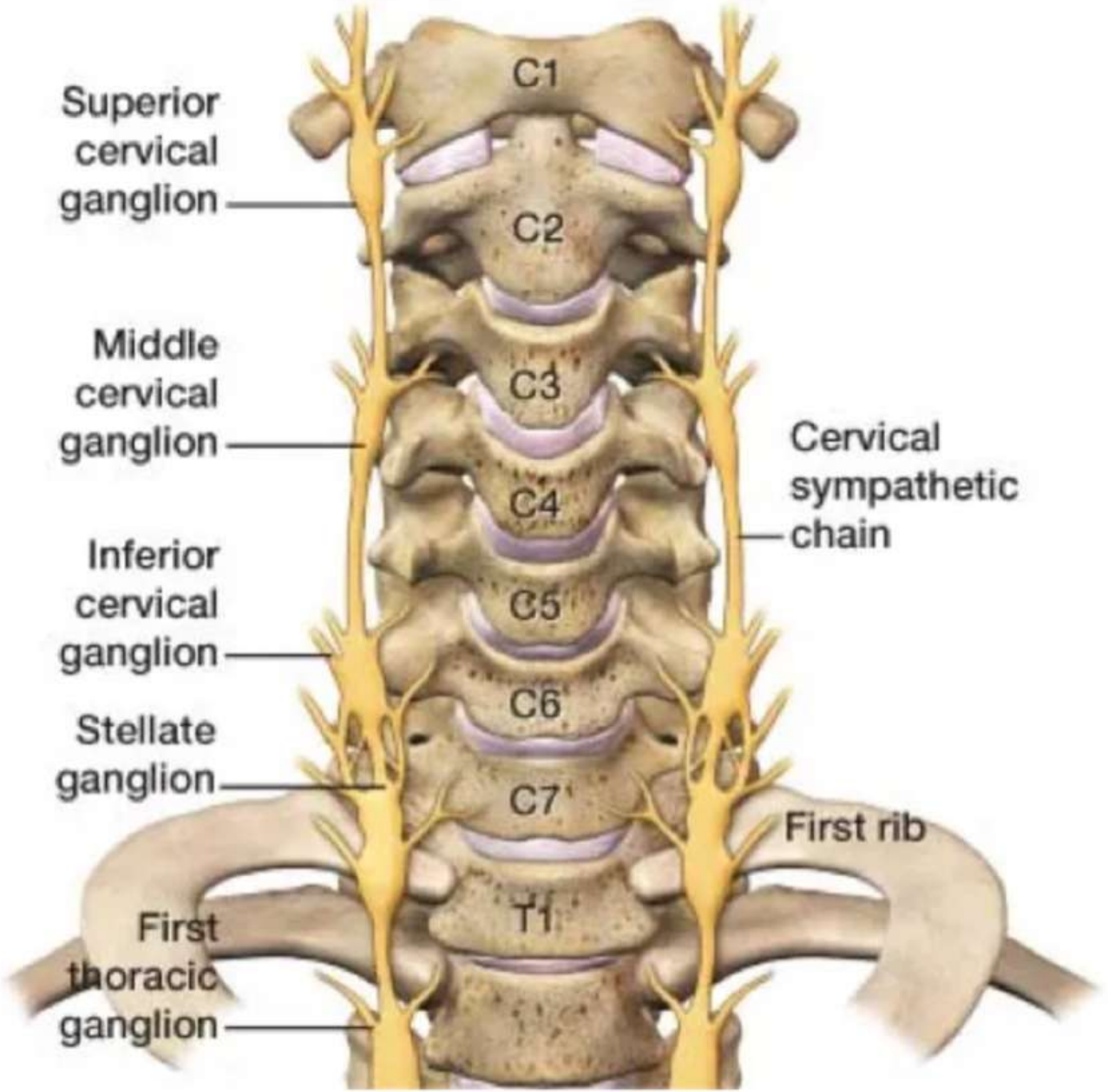
Complications of spine surgery

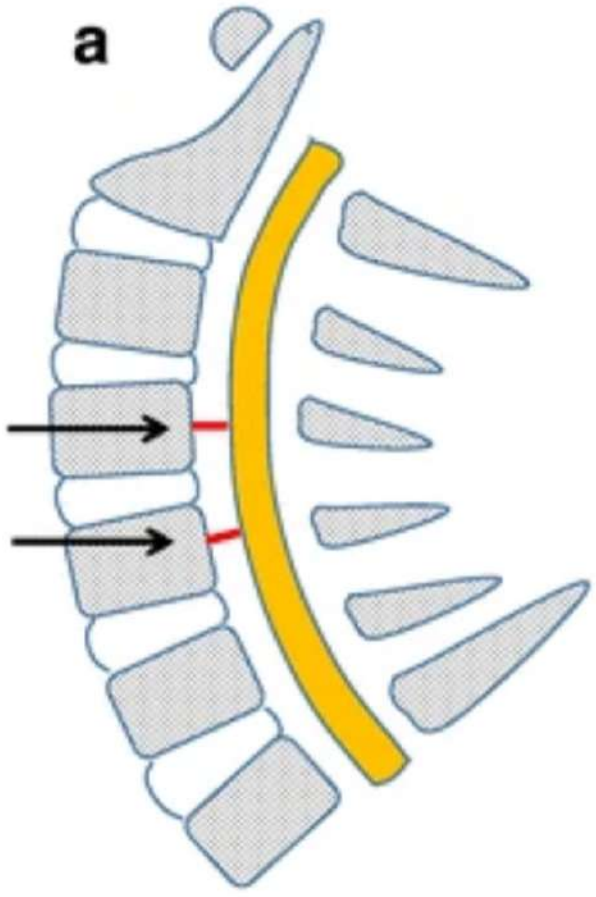
Neurological deficits

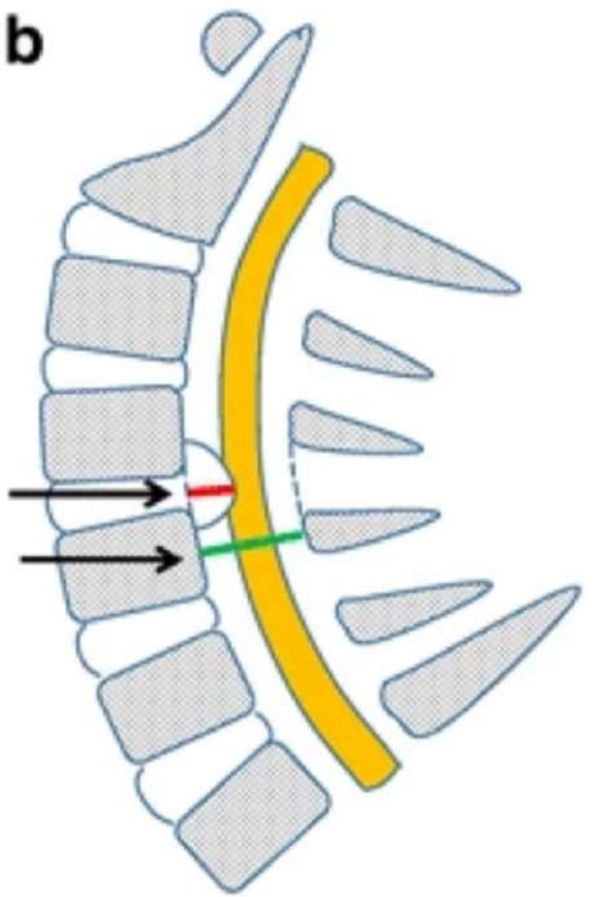
- Positioning
- Decompression
- Instrumentation
- Deformity correction
- Post op hemetoma
- Vascular occlusion





The stellate ganglion can be seen at the level of C6/C7 on the left hand side of the image.





Perioperative spinal cord injury (POSCI)

- Incidence is higher in :
  - Complex spinal deformities
  - Intramedullary tumours
  - Preexisting myelopathy

- Prevalence of neurological deficits - 0% - 10%

Risk factors for neurological deficits

Patient related

- Coagulopathy
  - History of radiation
- Cardiac conditions
  - Intramedullary tumor
- Congenital disorders
  - Neurocutaneous disorders
- Severe stenosis

Operative conditions

- Intra op hypotension/ blood loss
- Spinal instability
- Location
- Spinal instrumentation
- Revision surgery/ multilevel/ combined ant-posterior

MECHANISM OF NEUROLOGICAL COMPLICATIONS- intraop

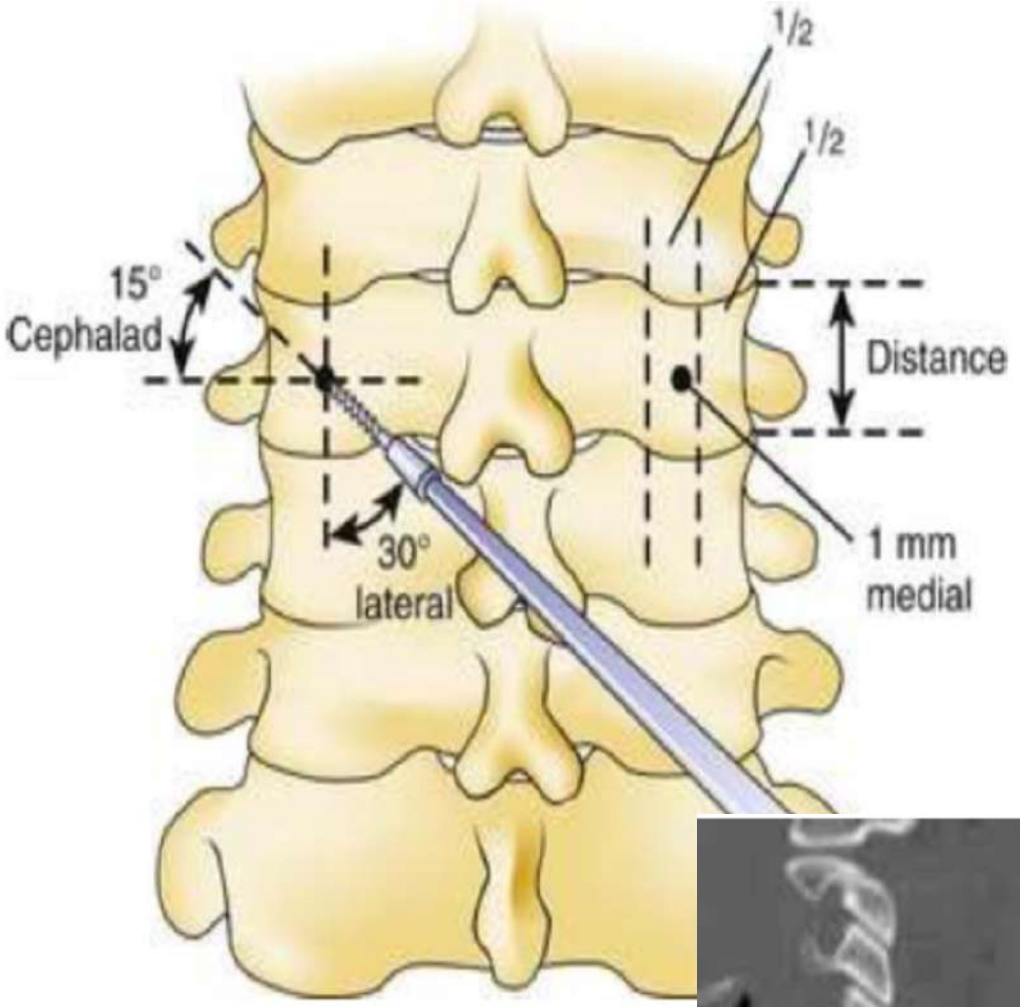
Direct trauma during placement of instruments : screw/hook/sublaminar wire

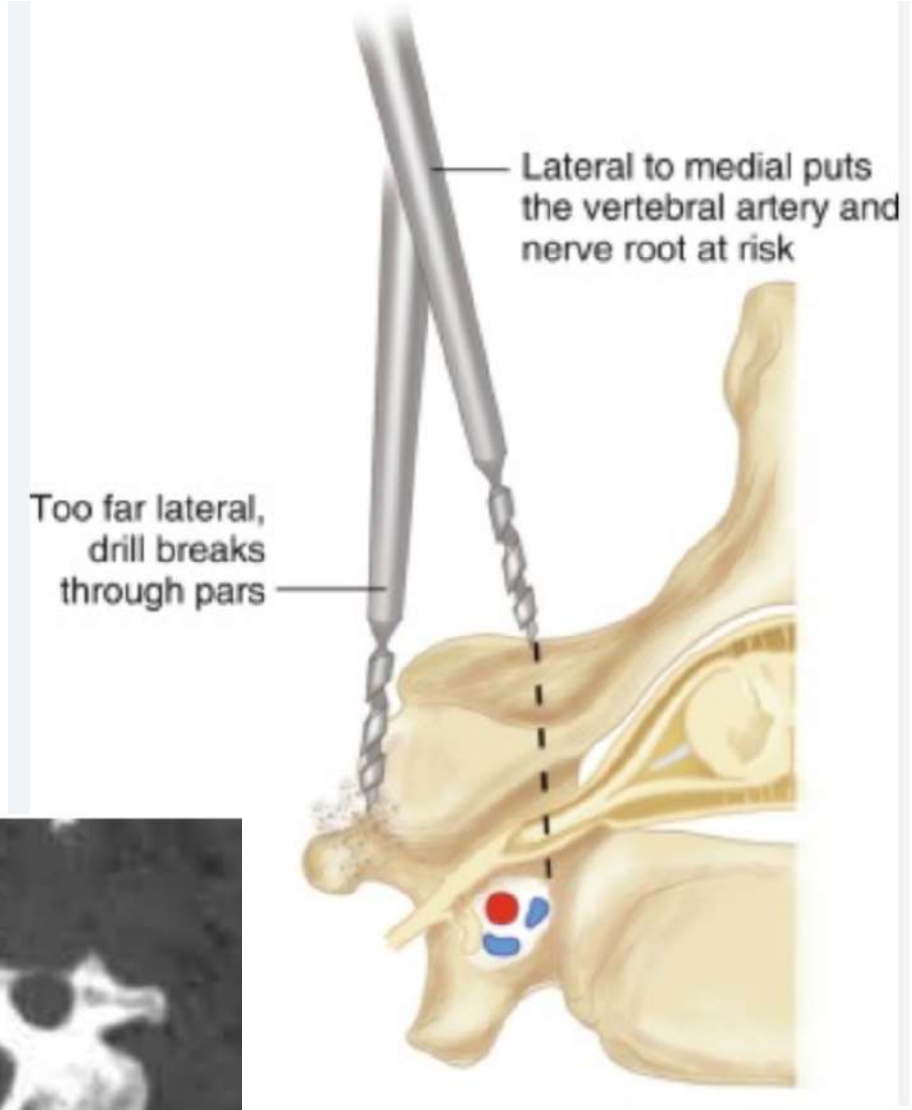
Intraoperative correction manoeuvres

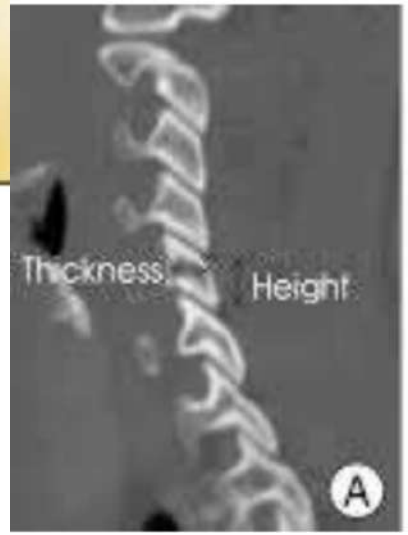
Spinal cord ischemia due to prolonged hypotension (MAP< 55mmHg)

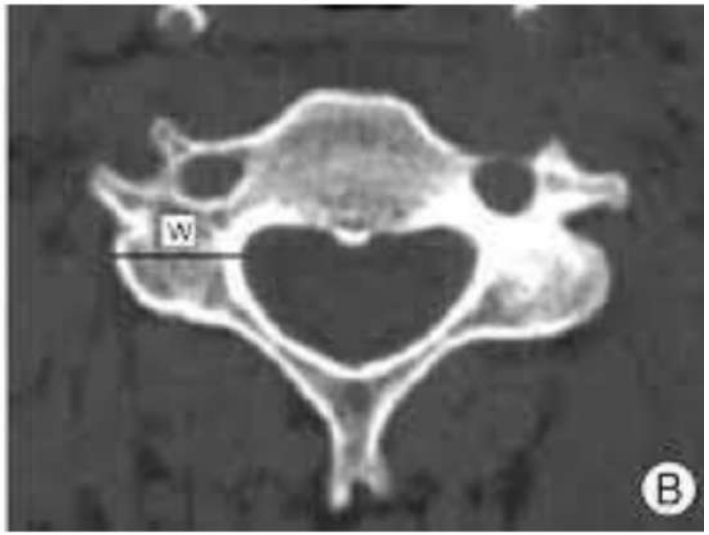
Hypoxia due to vascular compromise , low Hb

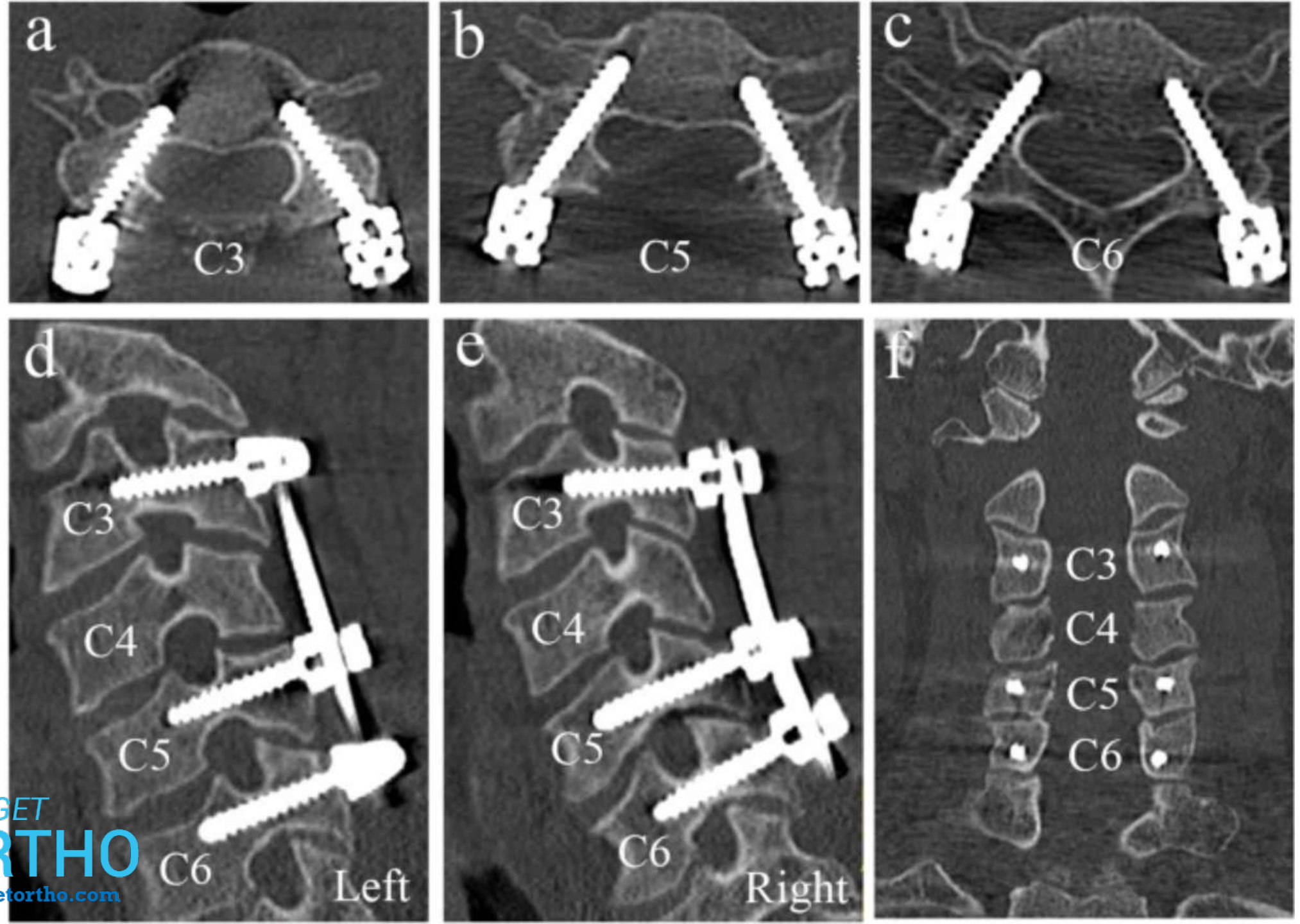
Cervical screw fixation

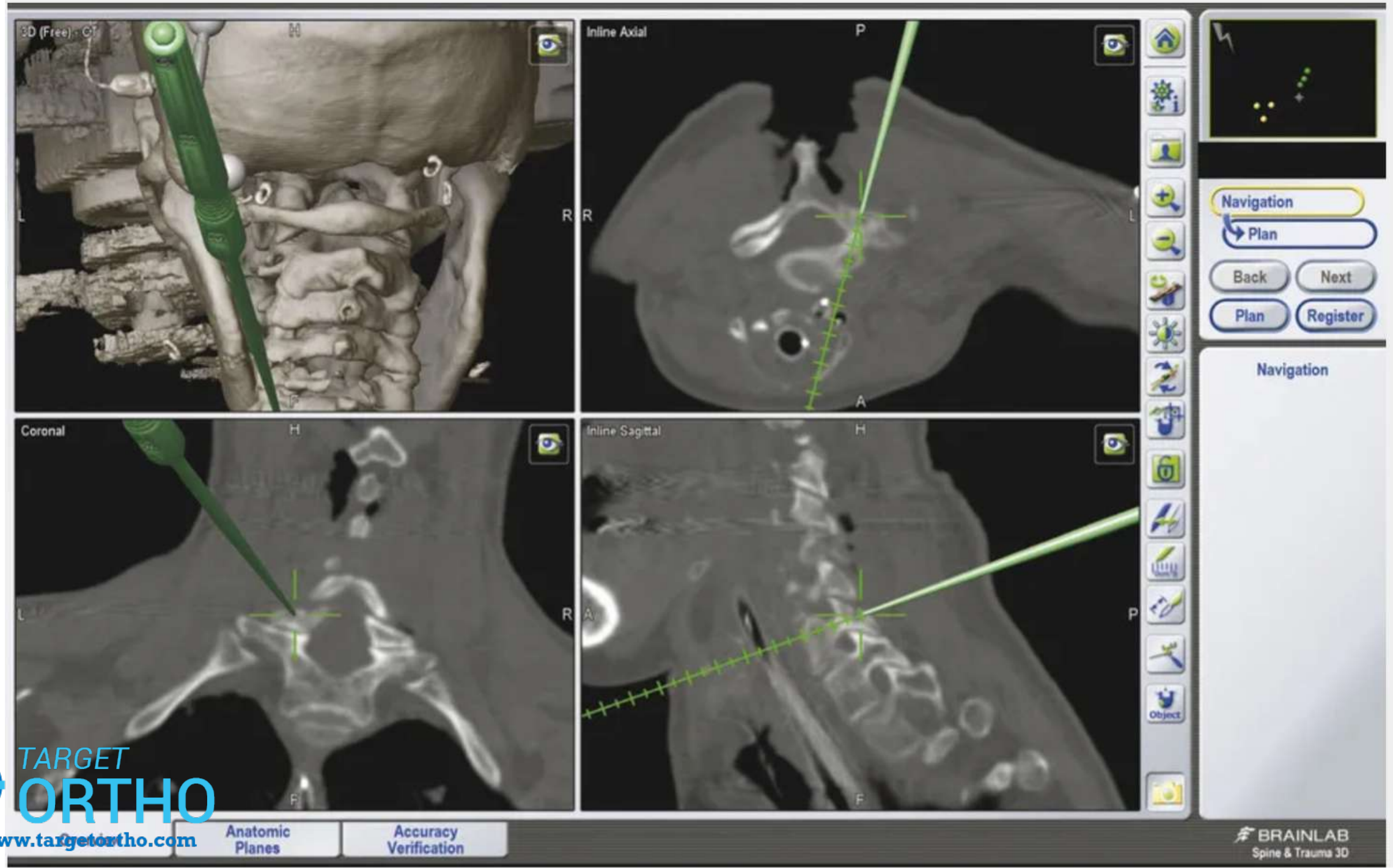




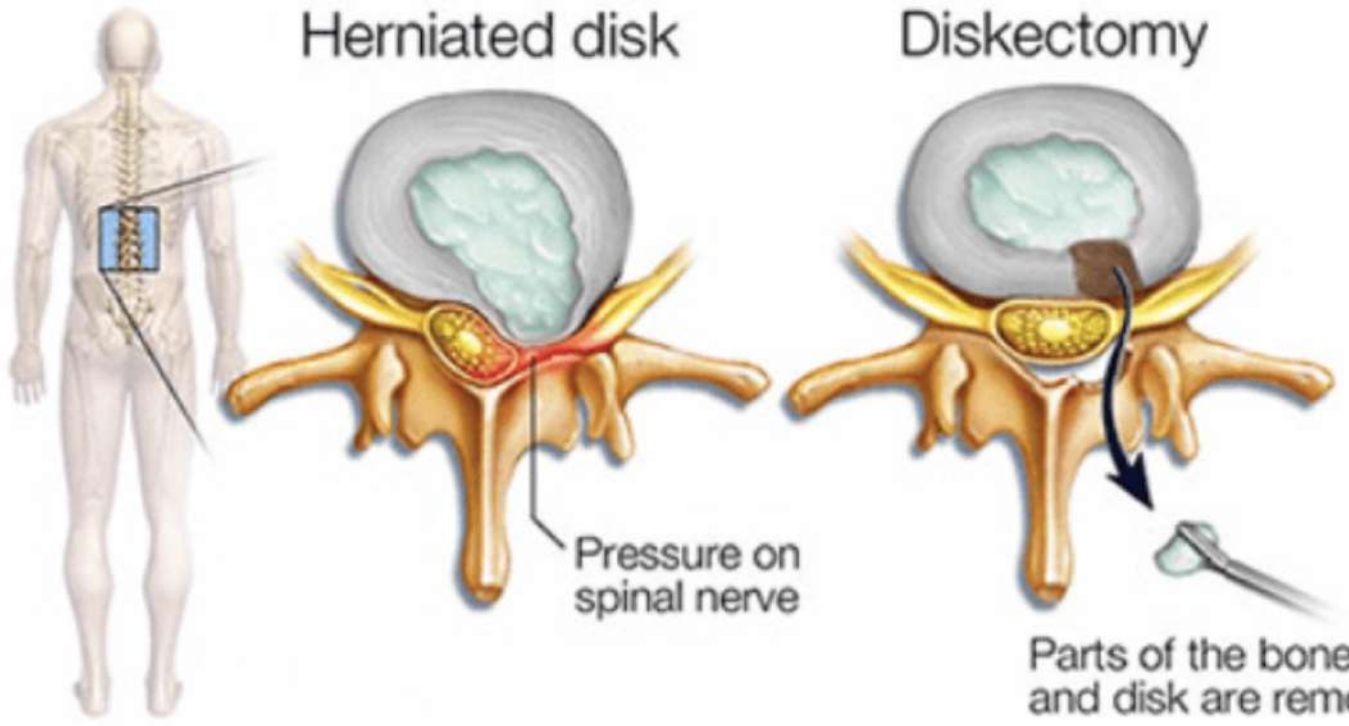


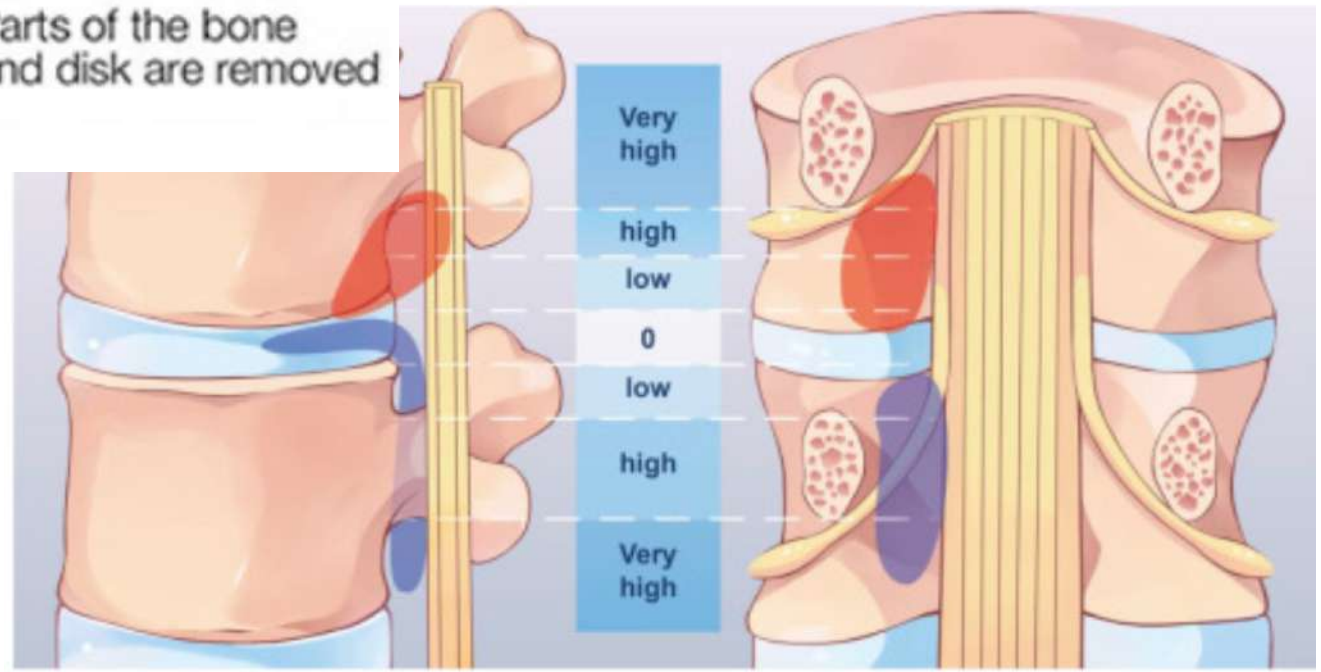




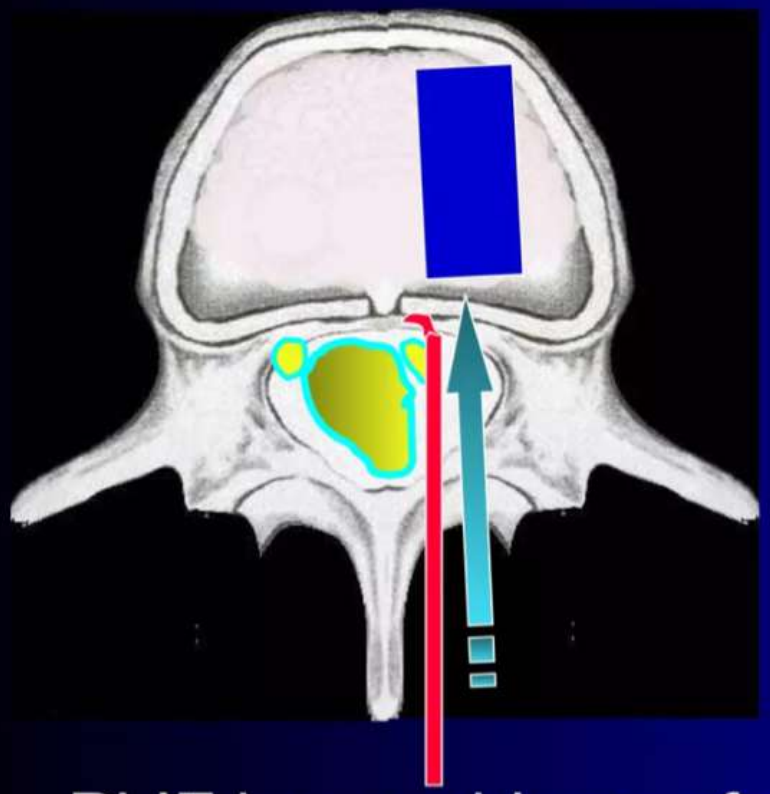


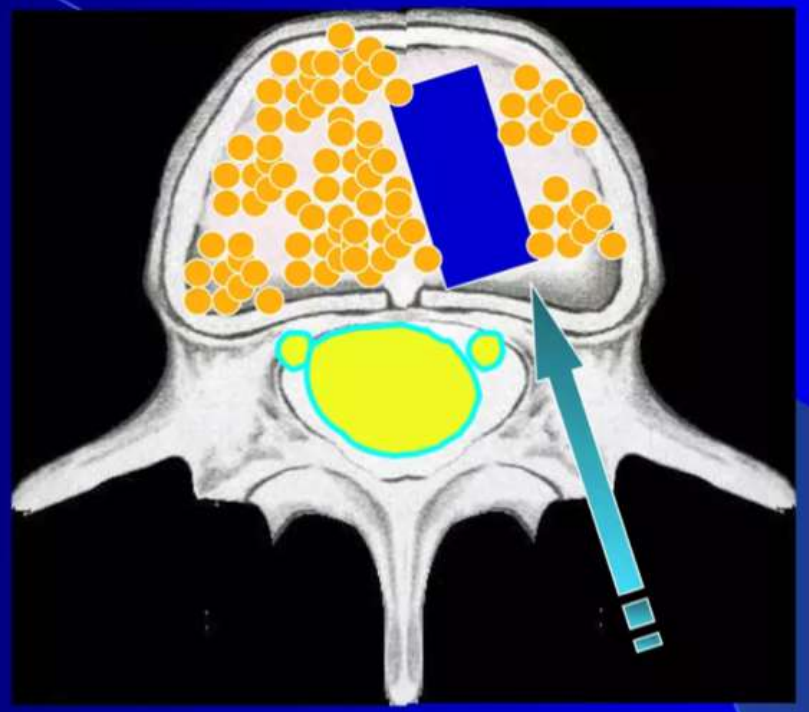
Thoraco lumbar surgeries





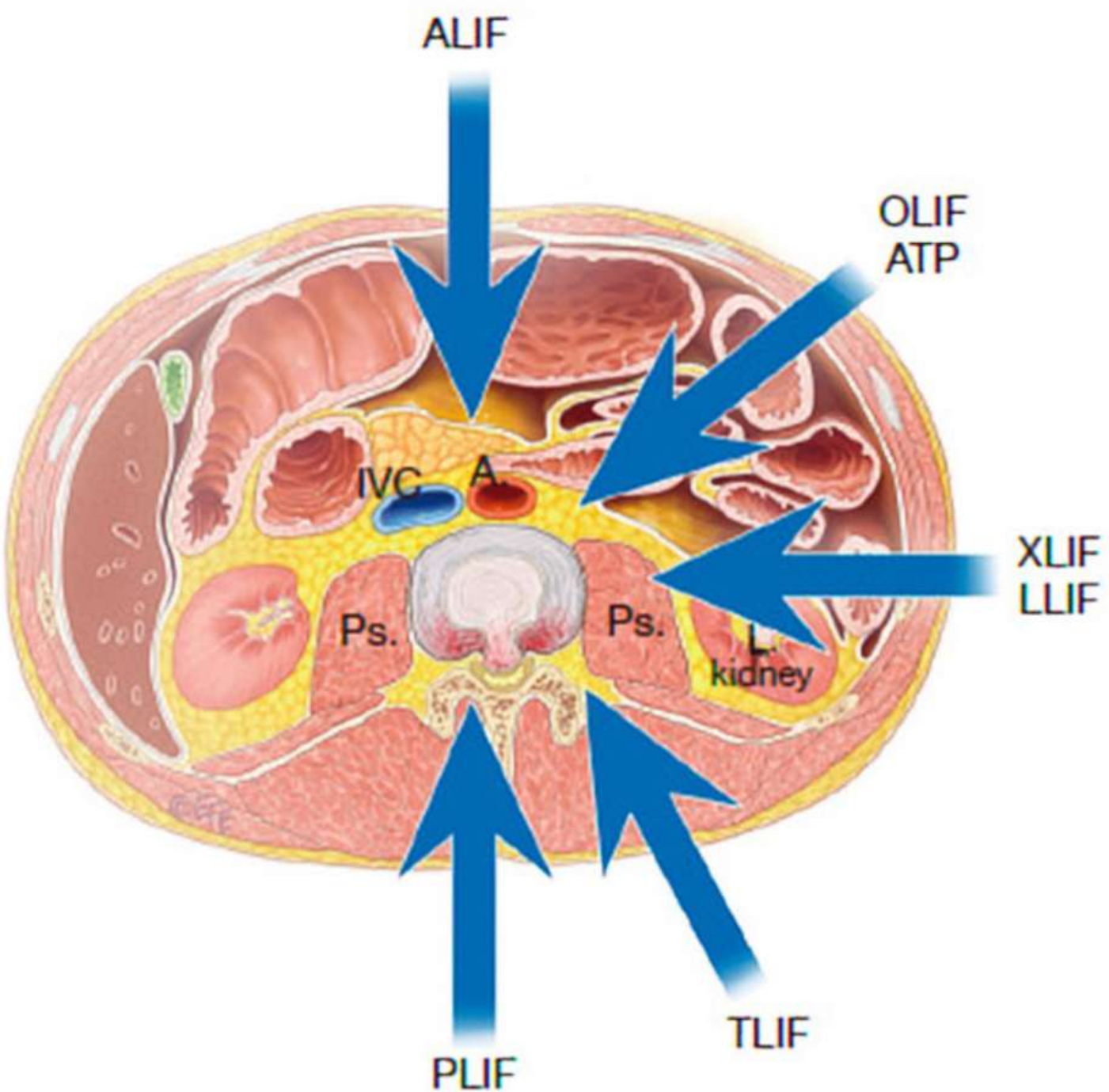
PLIF vs TLIF





PLIF has problems of distracting neural tissue

1. Nerve root or cauda equina injury 19% (Turner 1994)
2. Dural tear 10% (Ray 1997)



Neurological deficit in C spine

- Clinical presentation : quadri/paraplegia
- Prevalence:
  - 1-3%, 10% with OPLL – anterior approach
  - 0.18-0.64% with posterior approach
- Lateral mass screw – 1.8% breech – neurodeficit
- Mid cervical decompression- C5 palsy (early postop)- self resolving within 12 months

Neurological deficits of thoracic and lumbar spine

- Anterior approach 1% incidence of neurodeficits
- *Thoracic critical zone* :T4-T9 watershed- delayed paraparesis/paralysis
- Breech during pedicle screw insertion : 0.8% incidence of neural injury
- Incidence higher in PLIF >ALIF>TLIF

PREVENTION OF NEUROLOGICAL DEFICITS

- METICULOUS PREOP PLANNING
  - Informed team – surgeons and anesthetists
  - Defining the POSCI risk preoperatively
  - Padding of bony prominences
  - Optimal MAP 65-70mmHg or 85-95mmHg for thoracic stenosis

PREVENTION OF NEUROLOGICAL DEFICITS

- Use of neuromonitoring
- Multimodal Intra-op monitoring- navigation
- Drain – prevent hematoma/ abscess

Post operative management

- ICU
- MAP always >80mm Hg
- Neurological exam 12-24 hours to assess the neuro-deficit

Medical Management

- Methylprednisolone
  - loading bolus of 30mg/kg over 15 min
  - f/b 5.4mg/kg/hr as 23 hour infusion- upto 2 days
  - To begin within 8 hours of injury
- Intravenous lidocaine 2mg/kg – vasodilation
- Riluzole (sodium glutamate antagonist)- neuroprotective

Delayed onset Post op neurodeficits

- Uncommon
- Progressive spinal cord ischemia secondary to traction/ hematoma
- Management :
  - MAP>80mmhg
  - Temperature>36.5^{o}C
  - Initiate steroids
  - Repeat imaging If needed – early re-decompression

Dural tear

DURAL TEARS

- Incidental durotomy(dural tear)- most common complication
- Incidence-1- 18%(lumbar dural tears) ,0.3 to 4% cervical dural tears, increased risk in revision procedures
- Usually iatrogenic owing to anatomic variations /abnormality of post elements (spina bifida occulta)but can be secondary due to connective tissue disorders
- Most common location – dorso or dorso lateral aspect in posterior spine surgery

ETIOLOGY

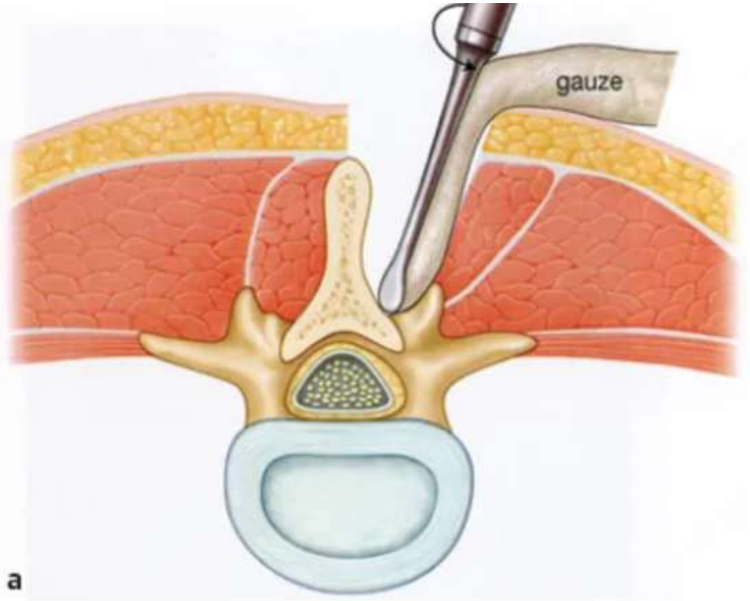
- Chronic spinal stenosis – obliteration of epidural fat &thinning of dura
- Inserting foot plate of Kerrison rongeur into the spinal canal without ensuring enough space availability
- Sharp bony margins may injure bulging dural sac
- Burr accidental slip –shreds dura
- Slippage of instruments –tap,screw tips,boneawl,pedicle path finder
- Pedicle screw medial wall breach
- passage of sublaminar wires – inappropriate teachnique

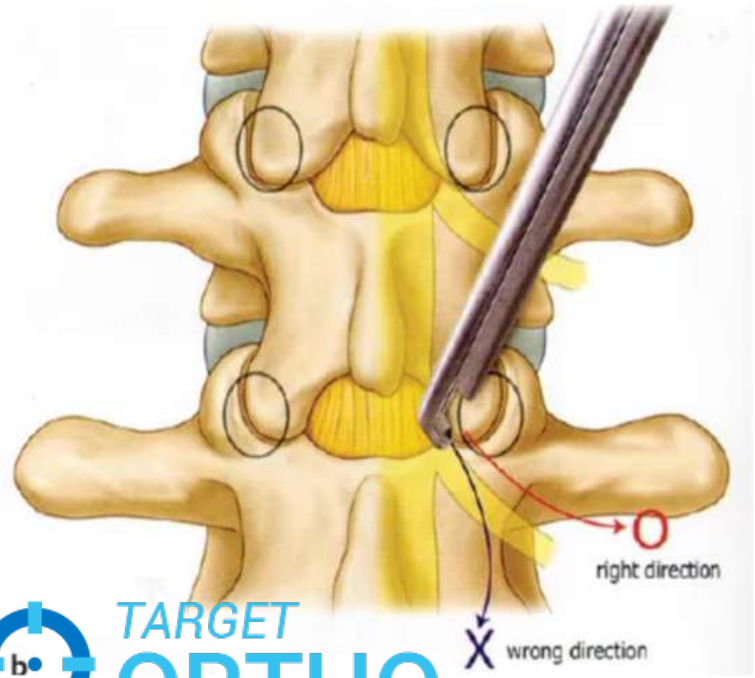
Prevention

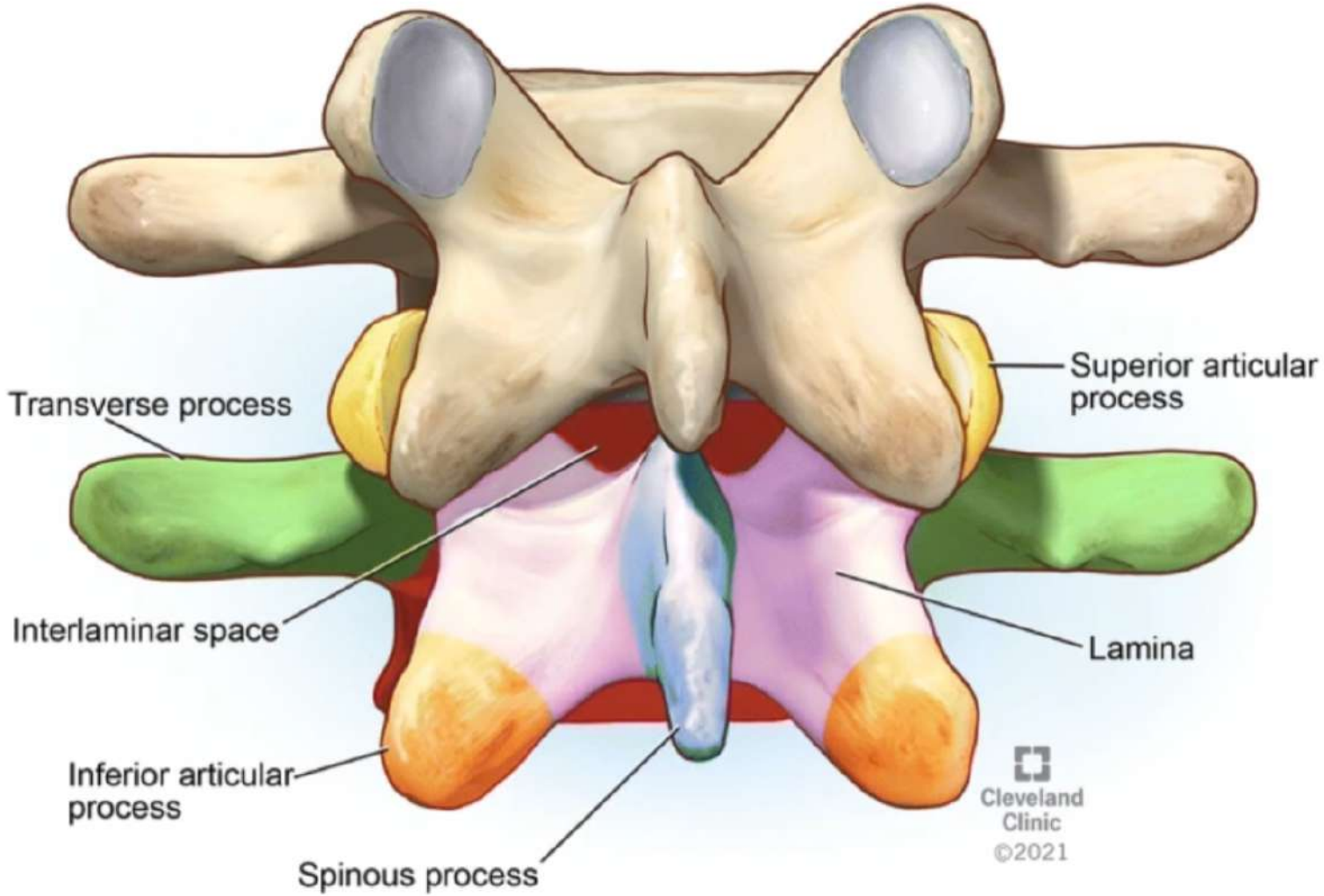
- Use of magnification lens and adequate illumination
- Proper positioning and adequate hemostasis ensuring proper visibility of dura and neural elements
- Adequate exposure
- Marking the operating site- needle placed away from midline
- Avoid slipping of diathermy and other instruments
- Insertion of screws prior to decompression
- Extreme care while using burr and ultrasonic cutters

Prevention

- Central decompression - caudal to cephalad
- Midline decompression starts in the midline v of the lamina and upwards and outwards
- Lateral decompression - cephalad to caudal along the direction of the nerve roots- tilting the table to opp side provides better visualisation of lateral recess

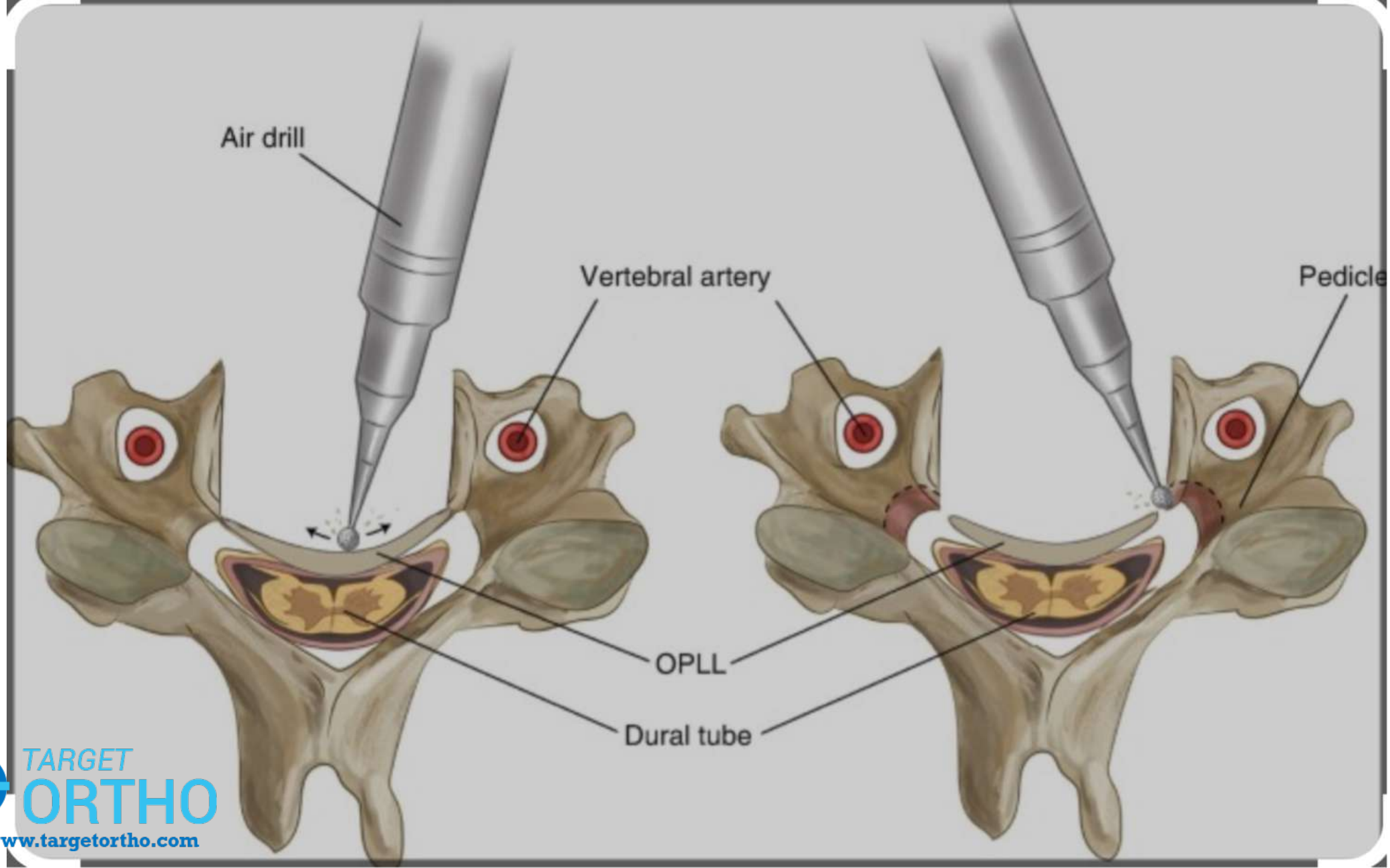






Prevention

- Dural adhesions – plane has to be developed between dural and flavum using dural dissector or cottonoid
- Discectomy done only after visualing traversing nerve root , also disc punch must be opened after entering disc space right angle to dura
- In opll and oyl cases– use of floatation technique
- In revision cases – start from normal area and then proceed to scarred area



Diagnosis and management

- Intraoperatively direct visualisation of clear fluid

- If missed intraoperatively – clear watery fluid in suction drain/wound site (normally blood decreases in 2nd and 3rd pod in suction drain whereas csf increases)

- Watery discharge from the wound & low pressure headach

Diagnosis and management

- Estimation of b2 transferring in clear fluid and halo sign
- Pseudomeningocoel(painless swelling in the back)/durocutaneous fistula increases chances of infn in immunocompromised patients
- Mri – best for diagnosis –hypointense on T1 and hyperintense in T2
- CT myelography or radioisotope cisternography- Csf fistula

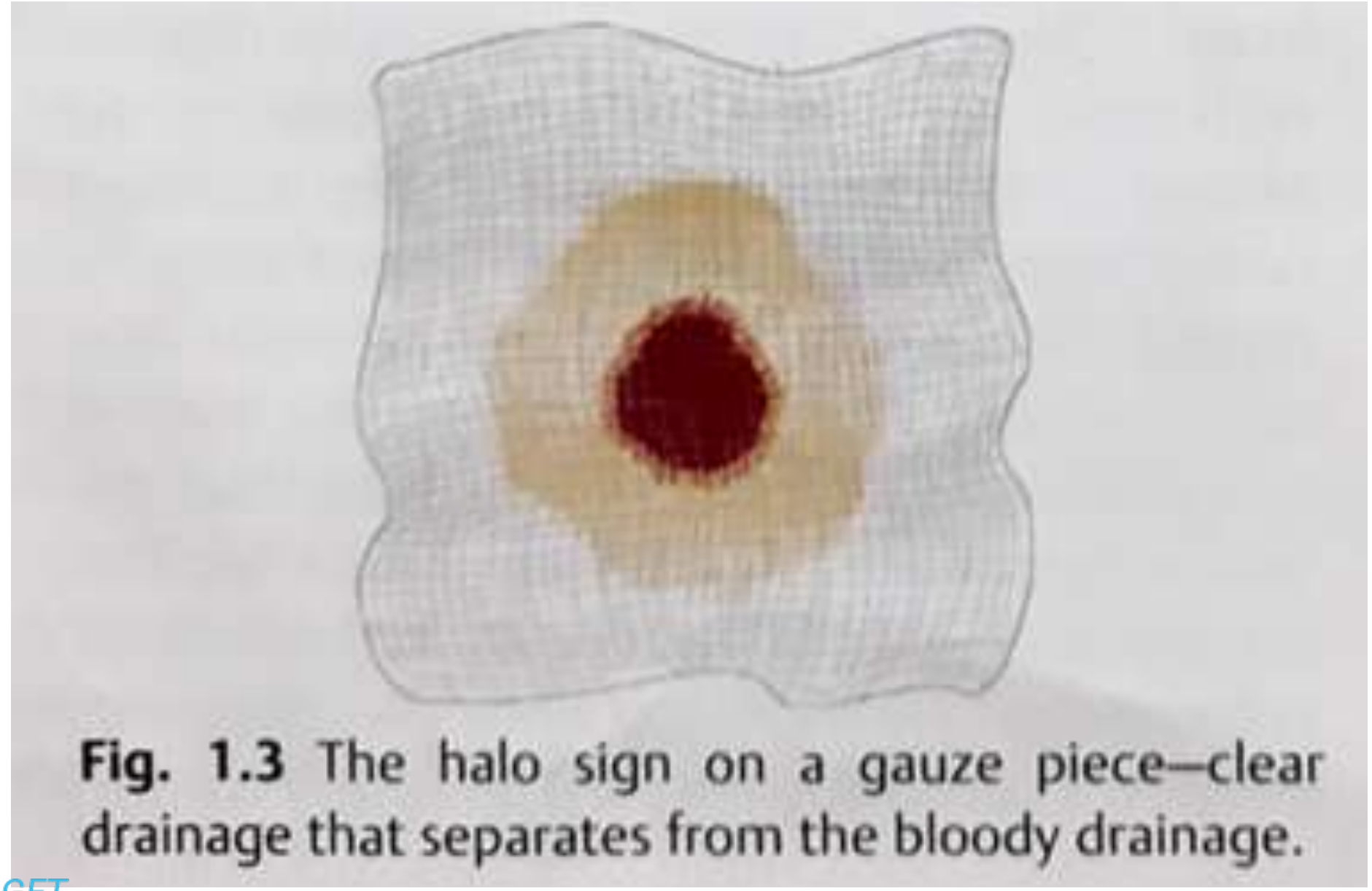


Fig. 1.3 The halo sign on a gauze piece—clear drainage that separates from the bloody drainage.

Fig. 1.2 Clear fluid oozing from the wound. It could be a cerebrospinal fluid (CSF) leak, an infection, a resolving hematoma, or fat necrosis.

Fig. 1.4 Postoperative asymptomatic pseudomeningocele.

5 MRI scan showing a pseudomeningocele.

Management of Dural tears

Intraop dural tear –

- Headlow position ,
- Low pressure suctioning over the cottonoid,
- Bone decompression shld be extended for adequate visualisation
- ,Any prolapsed nerve root should be meticulously pushed inside ,
- Retraction shld be avoided as cushion of csf is not there & it leads to direct pressure over the rootlets
- Primary repair or multilayered watertight closure of fascia,muscles

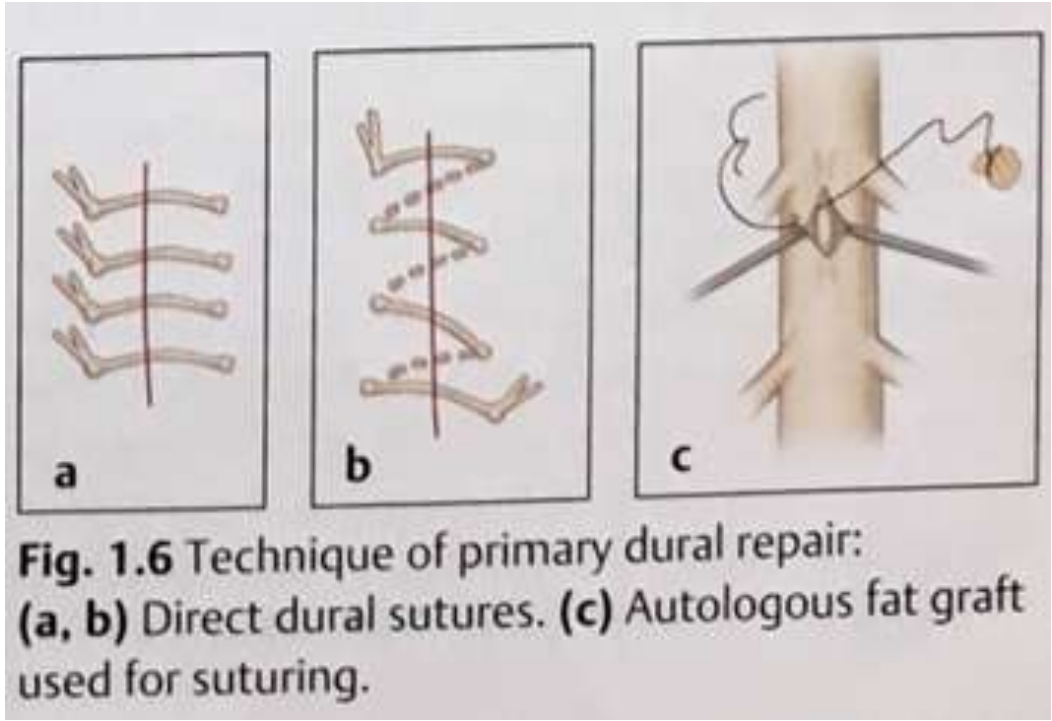


Fig. 1.6 Technique of primary dural repair: **(a, b)** Direct dural sutures. **(c)** Autologous fat graft used for suturing.

Dural tears in post op period

- Epidural blood patch –inj of 20-30 ml blood to promote formation of clot
- Oversewing the wound
- Lumbar subarachnoid drainage /csf diversion
- Re-exploration & repair

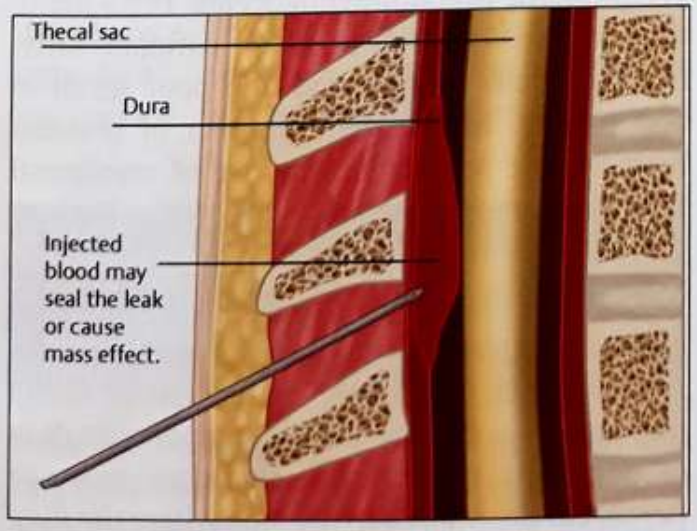


Fig. 1.7 Technique for epidural blood patch for dural leak.

Fig. 1.8 Technique of oversewing gauze piece over wound to treat a dural leak.

Management of accessible dural tears

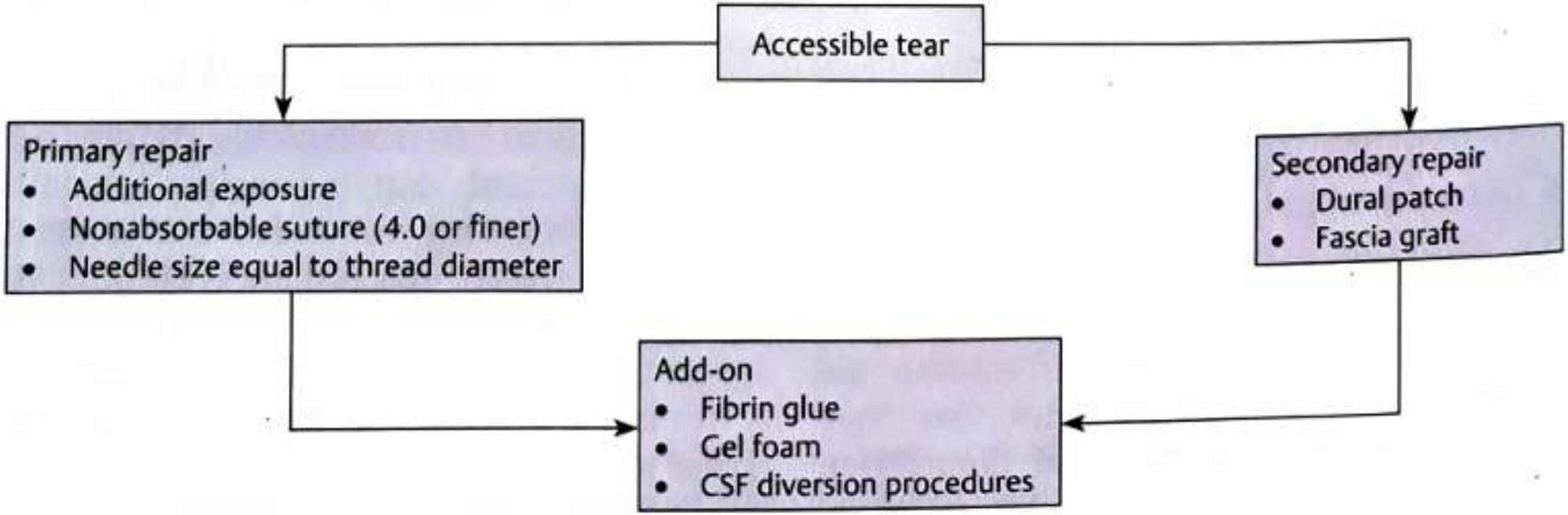


Fig. 1.11 Algorithm for managing accessible dural tears. CSF, cerebrospinal fluid.

Management of inaccessible dural tears

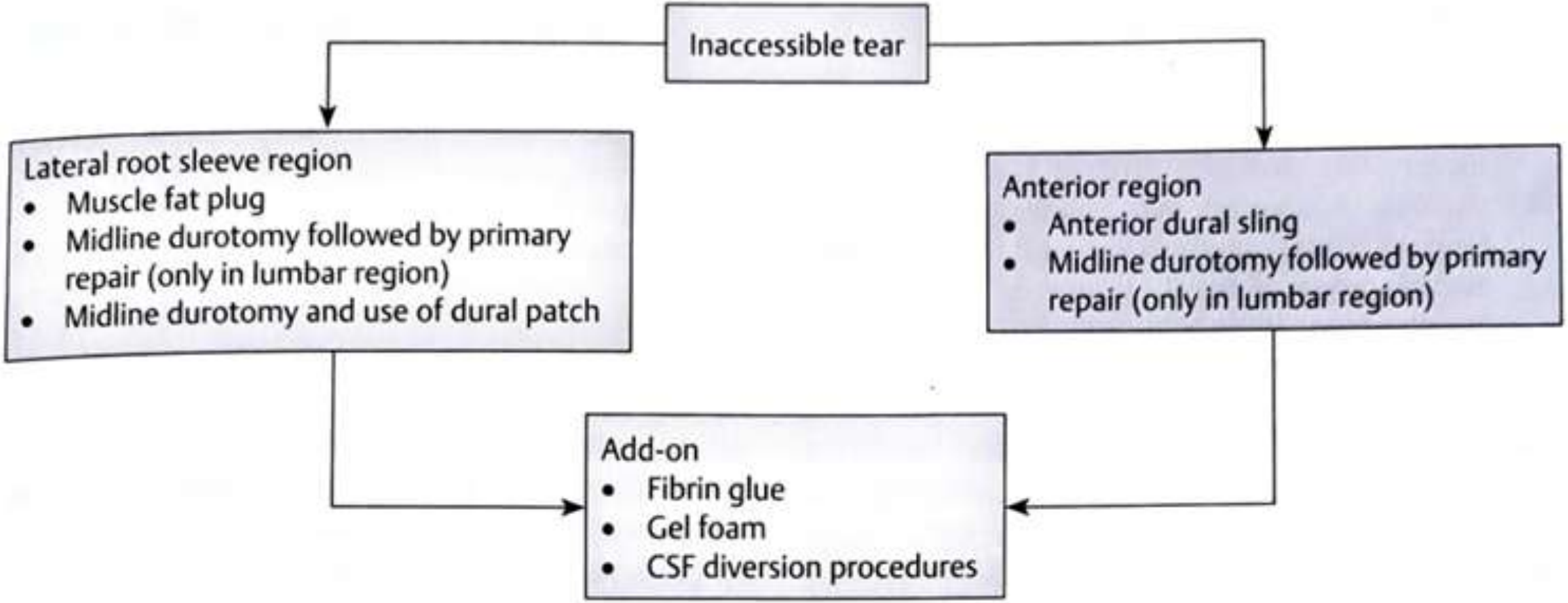
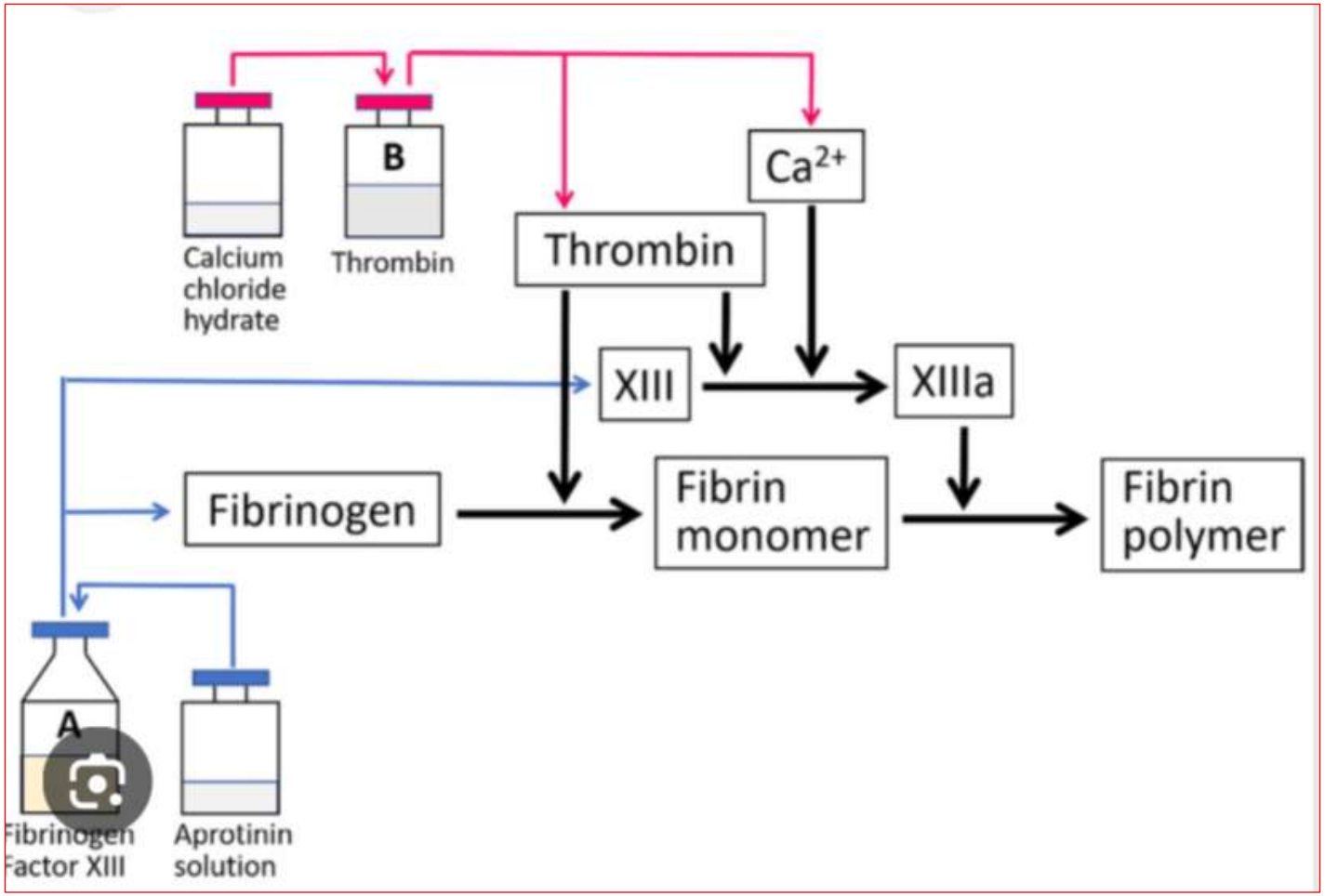


Fig. 1.12 Algorithm for managing inaccessible dural tears. CSF, cerebrospinal fluid.



VASCULAR INURY

- EPIDEMIOLOGY: MORTALITY RATE

  80 % WITH VASCULAR INJURY

  10 % WITHOUT VASCULAR INJURY

VASCULAR INURY

EARLY	LATE
INTRA OPERATIVE OR EARLY POST OP	DAYS OR WEEKS OR YEARS
REQUIRE IMMEDIATE INTERVENTION	EX:PSEUDO ANEURYSMS AND FISTULA

CAROTID ARTERY INJURY:

- DUE TO LATERAL RETRACTION IN ANTERIOR APPROACH –CAROTID ARTERY INJURY OR CEREBROVASCULAR ACCIDENT

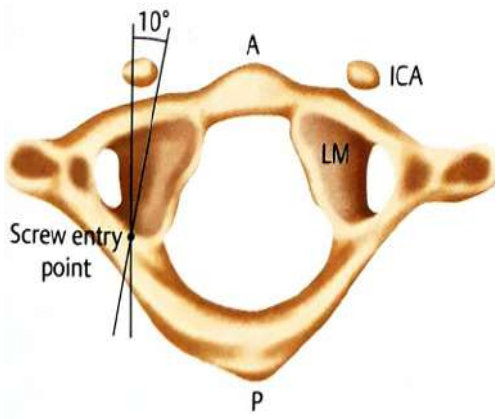
PREVENTION: Performing Retraction In 10 Min Interval

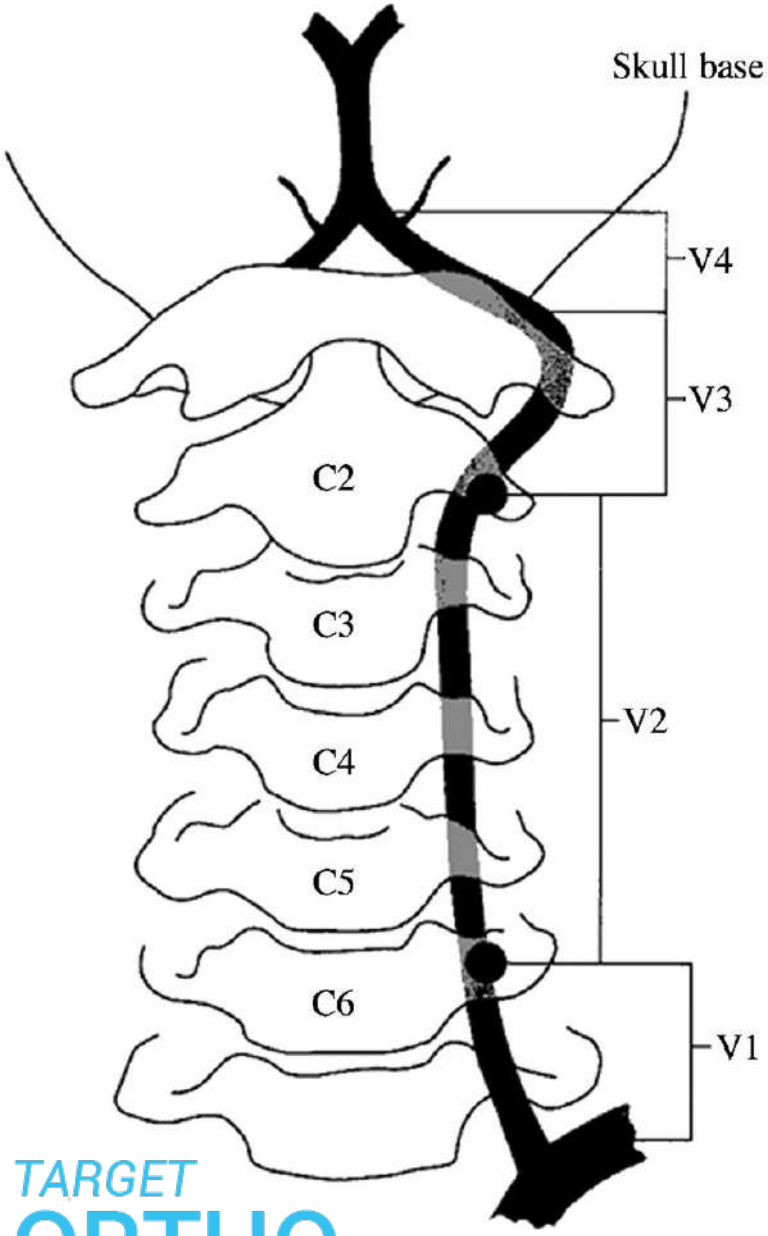
- ❑ Injury To the Internal carotid During Anterior Spine Surgery Is Rare

  Usually Seen In Patient With Medial Loop

- ❑ Chance Of internal carotid Injury During Posterior Instrumentation At Craniovertebral Junction Is High

- ❑Ica lies within 1mm of the ideal exit point of the bicortical transarticular screw or c1 lateral mass screw





V1 –preforaminal segment from subclavian to c6
Risk- slips laterally with retractors from vertebral body during acdf

V2 –from c6 to c2
Risk –in both anterior and posterior approach
During post approach vai most likely to occur due to misplaced cervical pedicle screw

V3-from c2 to c1
Advantage: tortous course
Injury occurs if dissection extend too laterally

V4-intracranial and intradural segment
Here artery ascends and joins its contralateral part at the lower border of pons

VERTEBRAL ARTERY INJURY

VAI WITHIN SCREW HOLE

- ✓Bleeding is not usually massive
- ✓Bleeding usually stops after insertion of screw
- ✓One side artery injured contralateral screw should not inserted it requires alternative mode of fixation

VAI INJURY IN OPEN SPACES

- ✓Difficult to identify due to massive bleed
- ✓Finger tampanode followed by application of gel foam floseal is recommended
- ✓ A permanent solution with repair, clipping or ligation is recommended to prevent ischemic damage to the brain

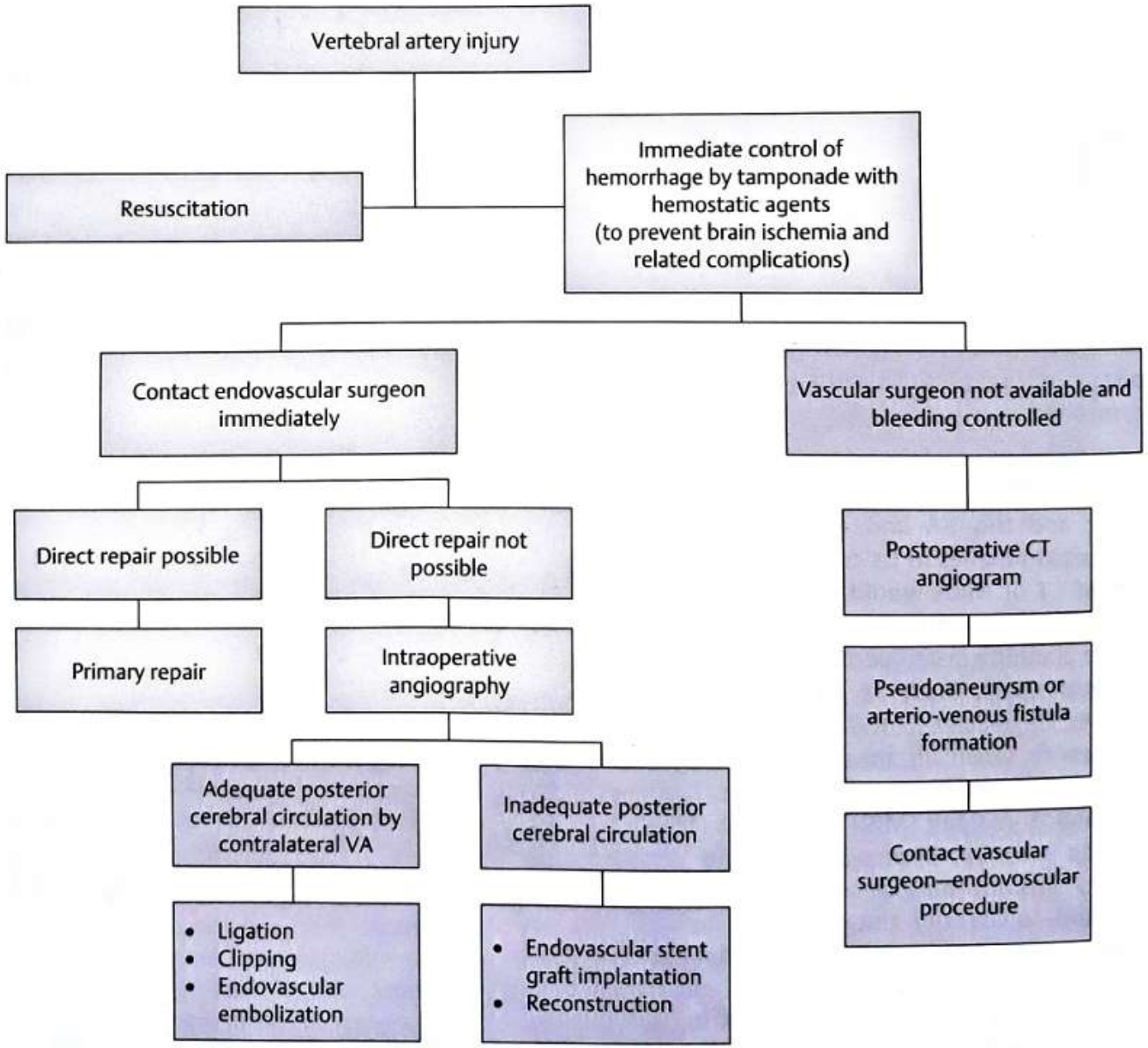


Fig. 2.9 Algorithm for management of vertebral artery injury.

ANTERIOR LUMBAR SPINAL APPROACH:

- Vascular injuries –venous injuries were more common than arterial injuries
- Most common cause –retraction of large vessel
- Most common vessel injured-left common iliac vein
- Level high risk-l4-l5

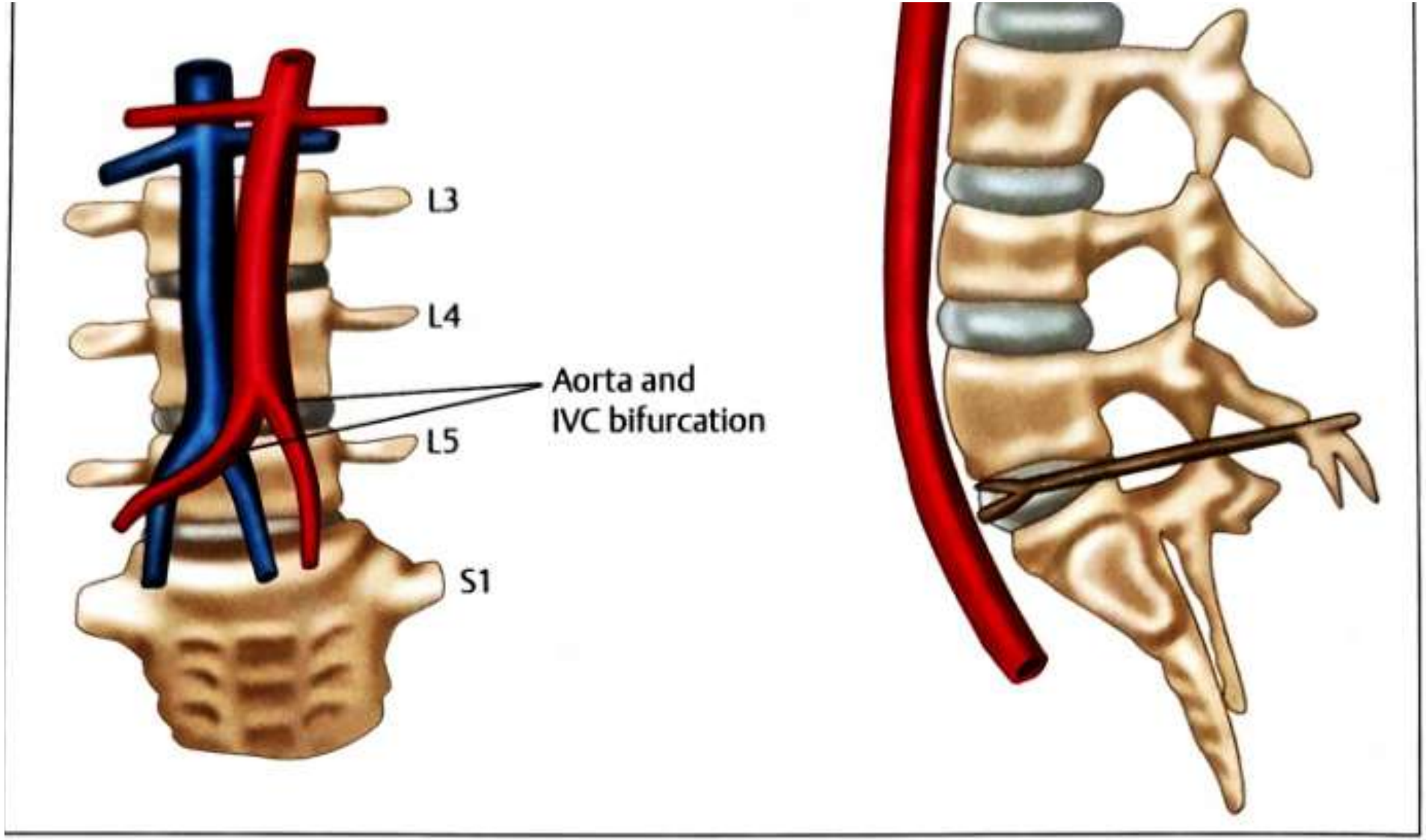


Fig. 2.11 Schematic diagram depicting possibility of injury to aorta and IVC by a pituitary forceps. IVC, inferior vena cava.

PREVENTION:

- Prophylactic femoral access can be performed for possible baloon blockade or prophlactic banding of thoracic aorta can be performed during thoracotomy
- Initial control: direct suture placement,pedicle screw placement in osseous canal or clamping
- Definitive treatment:primary suture, aortic patch plasty, segmental alloplastic reconstruction or endovascular stent

- Small lacerations or puncture of the common or external iliac can be treated with direct repairs
- In large defects where suture is not possible sutureless techniques like a combination of topical structural and hemostatic agents are used

PSEUDOARTHROSIS

- Pseudoarthrosis is the inability to achieve a solid bony union of the motion segment even after 1 year of index fusion surgery.
- Incidence – 5 %to 35%
- Diagnosis can be suspected 6months post spinal fusion procedure
- Biology –Osteoinduction ,Osteoconduction,Osteogenesis

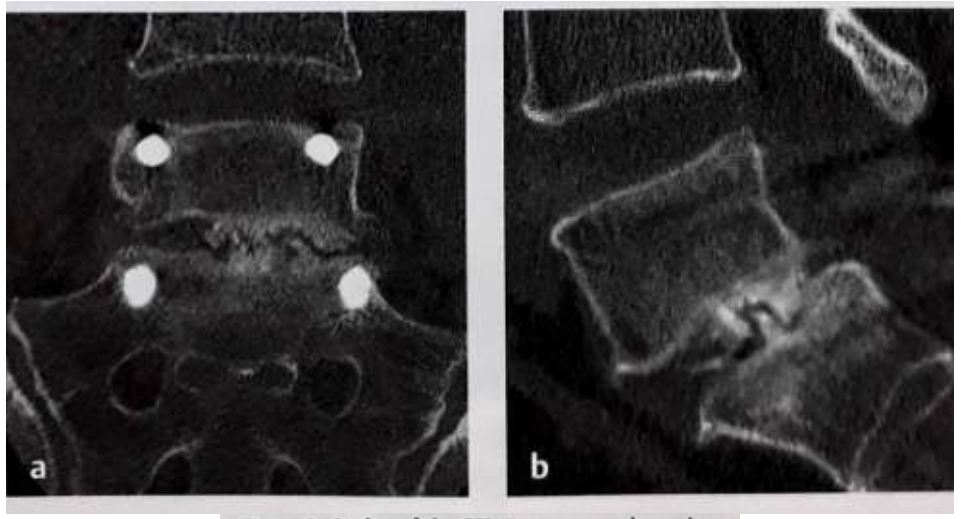


Fig. 9.9 (a, b) CT images showing intradiscal gas shadows at L5–S1 with implants in situ, indicating pseudoarthrosis.

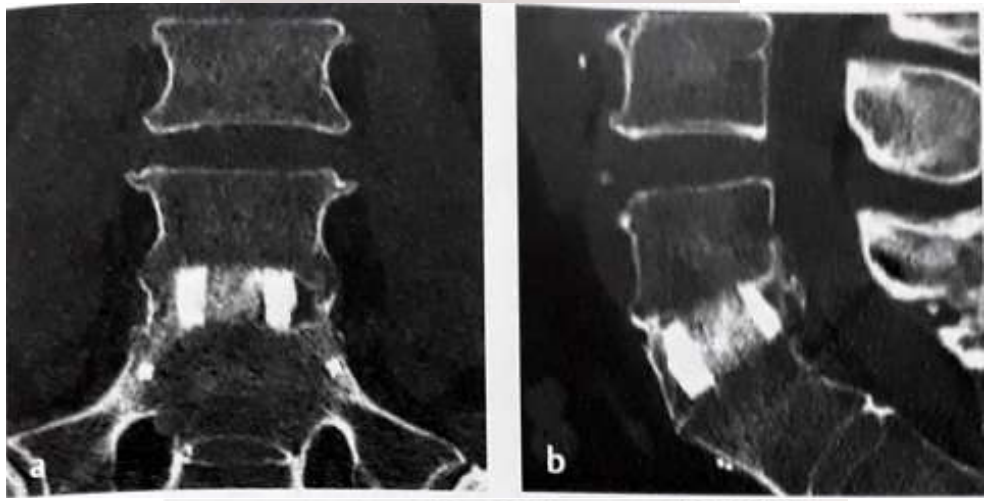


Fig. 9.10 (a, b) CT image showing solid union with continuous trabecular bone formed inside the metallic cage and around it.

Optimal steps to achieve fusion

1)Preparation of the host bed –decortication of the fusion surfaces and provision of a healthy vascular soft tissue envelope

2)Delivery of bone graft /bone substitutes

3)Instrumentation –stabilisation of the fusion segment reduces the micromotion at the graft host interface allowing new bone to be formed

Table 9.1 Risk factors for spinal pseudoarthrosis

Patient related	Technique related
• Elderly age	• Inadequate graft bed preparation
• Osteoporosis	• Poor handling of muscles
• Hormonal imbalance	• Noninstrumented fusion
• Nutritional imbalance	• Inadequate stability
• Hematologic disorders	• Posterior/posterolateral fusion compared with interbody fusion
• Drugs—NSAIDs, corticosteroids, and chemotherapeutic agents	• Increased number of fusion levels
• Smoking	• Alteration of sagittal balance

Abbreviation: NSAIDs, nonsteroidal anti-inflammatory drugs.

Types of spinal pseudoarthrosis

Heggeness &esses in 1991 –based on morphology

1)Atrophic type –absence of significant new bone formation between spinal bony ends
2)Transverse type – adequate bone formation seen ,but there is a transverse line of discontinuity in fusion mass
3)Shingle type – Discontinuity in the fusion mass is in an oblique trajectory
4)Complex type –more than one complex defect

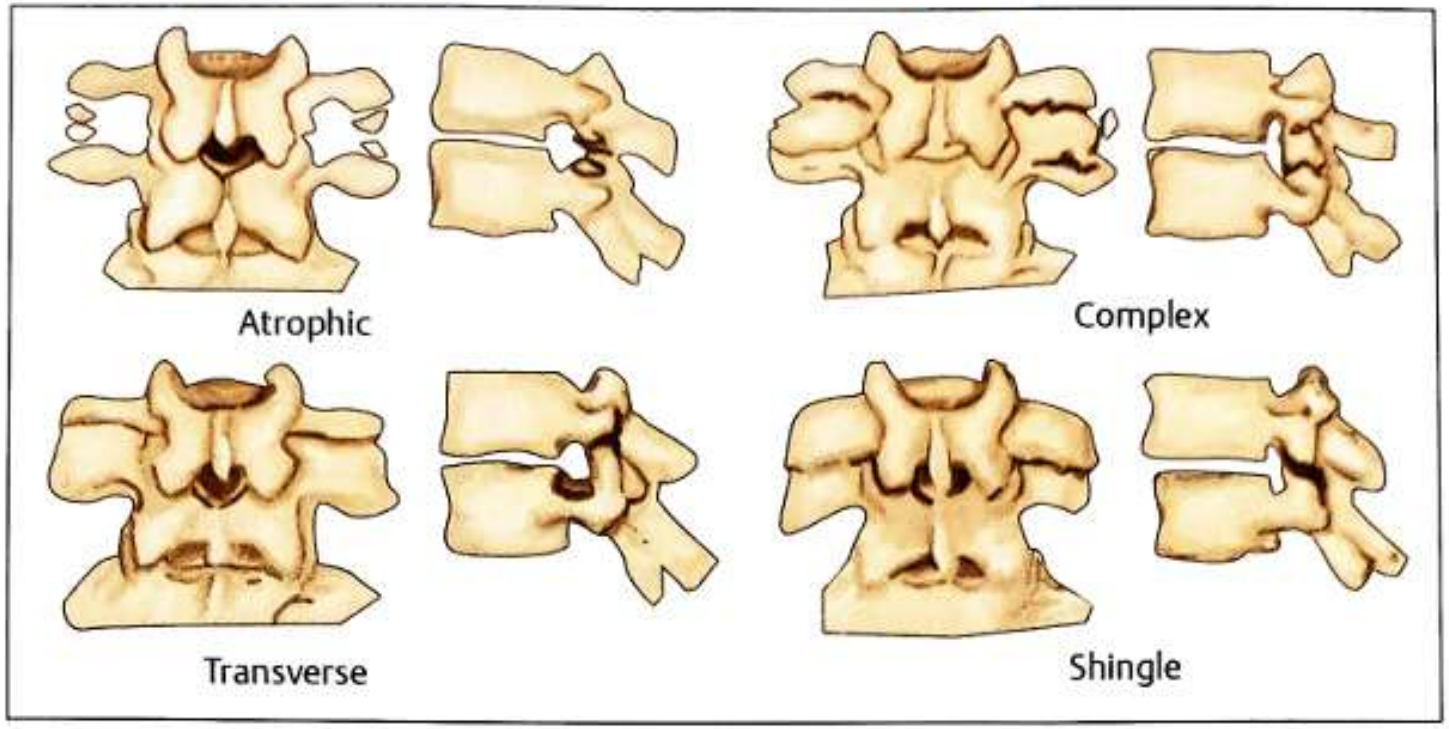


Fig. 9.7 Classification of pseudoarthrosis.

- Atrophic type – have no load bearing or sharing potential
- Other types – have load bearing capability

Clinical features

- Recurrent low back pain with /without radiating pain ,paresthesia ,burning sensation after a interval period free of pain following index procedure
- Implant loosening or back of screwsWorsening of deformity following long fusion construct

- Investigations
- Static and dynamic x rays
- Mri
- Ct scan –most reliable method
- Bone scan or SPECT scan

CT protocols have been developed to monitor the progress of interbody fusion, in which CT scans are done at 3, 6, 12, and 24 months.[35]

- *At 3 months*: Early bone healing may be observed with lucency around the hardware indicating loss of fixation. Subsidence of interbody devices can be noted early in thin slice CT sections.
- *At 6 months*: Bridging trabecular bone laterally and within the interbody device can be observed. Bone fusion may be nearing completion with initial fusion starting lateral to the interbody cage. Presence of lucencies around the implant and defects in bridging trabecular bone indicate delayed healing. Intradiscal gas shadows seen in interbody fusion should raise suspicion of micromotion occurring at the device-host bone interface (**Fig. 9.9**).
- *At 12 months*: Mature trabeculation may be observed other than the findings seen at 6 months. Solid arthrodesis is generally observed during this scan (**Fig. 9.10**).
- *At 24 months*: It is performed only when solid fusion is not seen at 12 months. Consolidation of complete disk space may be observed. Presence of lucencies around implant or defect lines in trabeculations indicate nonunion.

Treatment algorithm

- Surgical exploration
- Electromagnetic stimulation

- **Infected Pseudoarthrosis**
- Uncommon occurrence
- Goal – to control infection and also to achieve fusion at the same time
- Treatment
- Debridement of infection , antibiotics
- Antibiotic loaded cement beads , vaccum suction

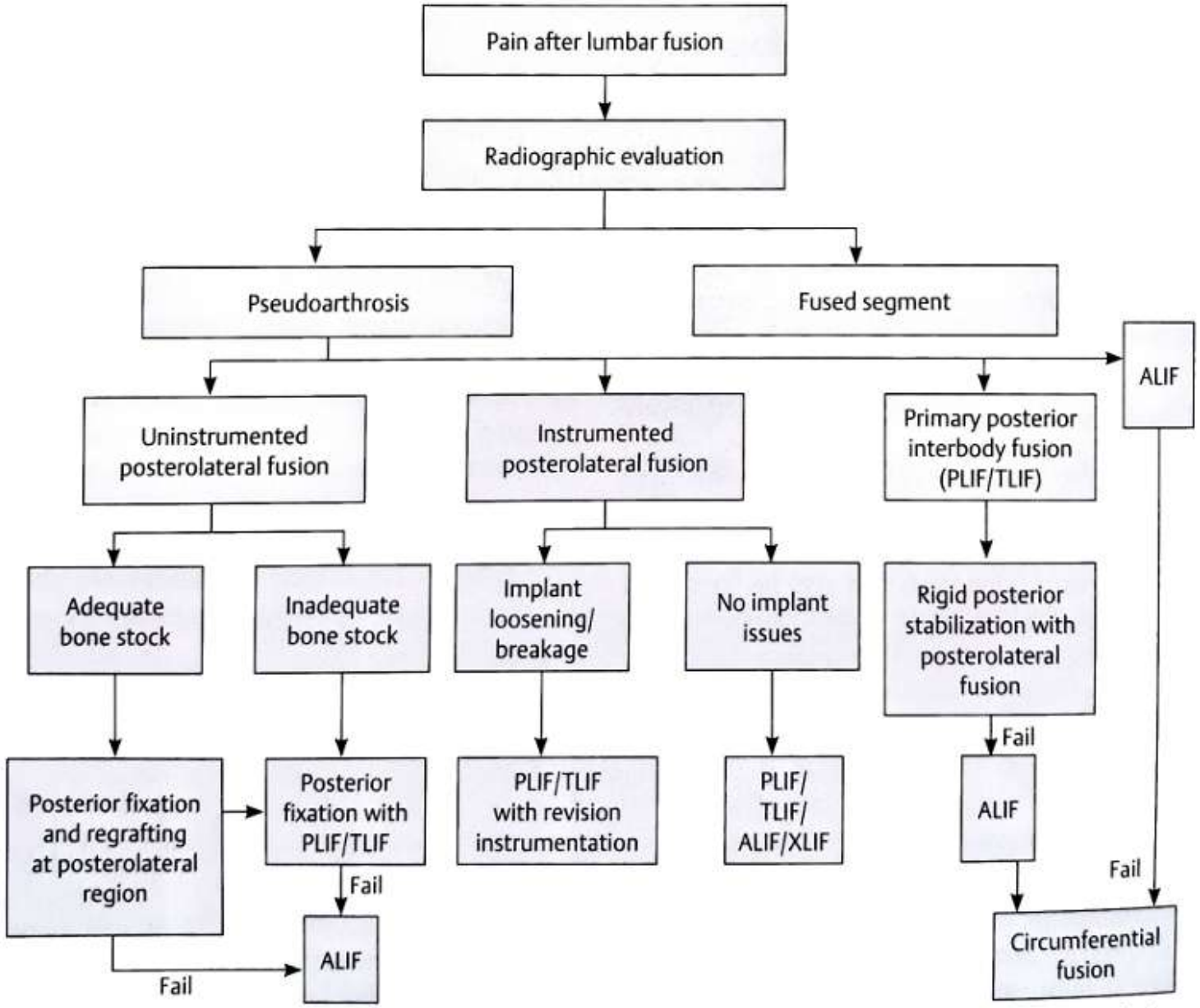


Fig. 9.12 Algorithm for management of lumbar pseudoarthrosis. ALIF, anterior lumbar interbody fusion; PLIF, posterior lumbar interbody fusion; TLIF, transforaminal lumbar interbody fusion; XLIF, extreme lateral

SURGICAL SITE INFECTION

- Cdc classifies SSI into superficial and deep infection
- Superficial infections-Infn involving skin and subcut tissues
- Deep infections-Deep infn disseminates along fascia and beneath resulting in discitis , osteomyelitis , epidural abscess

EARLY infection – infn during for 1st post op month

LATE infection-2-6 months post op

VERY LATE infection - >6 moths post op

Risk factors

Table 4.1 Risk factors for SSI

Factors	Variables
Patient dependent Modifiable	Smoking Alcohol consumption Obesity Diabetes Malnutrition Nasal carriers of *Staphylococcus aureus*
Non-modifiable	Age Rheumatoid arthritis AIDS
Surgeon dependent	Surgical technique Attention to asepsis OR discipline

Abbreviations: AIDS, acquired immunodeficiency syndrome; OR, operating room; SSI, surgical site infection.

Box 4.1 Checklist for operating room (OR) protocols

- Reduction and monitoring of OR traffic
- Use of laminar airflow
- Proper donning of OR attire including caps and mask
- Proper autoclaving; no "flash" autoclaving

Box 4.2 Intraoperative risk factors that impact surgical site infection (SSI)

- Longer operative times
- Case order
- High ambient temperature
- Theater traffic
- Laminar airflow
- Use of microscope
- Proper usage of operating room (OR) attire (gowns, caps, and masks)

Strategies for prevention

- Preoperative antibiotic prophylaxis
- Skin preparation and antisepsis
- Hand hygiene
- Double glove
- Topical vancomycin powder
- Povidone iodine irrigation
- Or traffic – reducing the no of ot personnel

Clinical features

- Superficial infection –localised tenderness, warmth,stretched shiny skin,edema,erethema
- Deep infection –unexplained progressive back pain 2 days to 6 months post op,radiating pain,paresthesia,fever spikes,anorexia , weight loss bedridden

DIAGNOSIS :

Blood :-ESR ,CRP , Serum procalcitonin , Serum amylase,Anemia,hypoproteinemia

Radiology – Xray ,MRI , ct

Diagnosis

- X rays – decreased disc space, end plate destruction , osteolysis,loosening of implants if any
- Mri - decreased disc space, loss of end plate definition , increased T2 signal in disc space and vertebral body due to edema , paravertebral or epidural collection
- Ct- bone destruction , pathological fractures,osteolysis around implants ,collection ,diagnostic ct guided aspiration of abscess or biopsy
- Radionucleod scan – tc99 or ga 67
- FDG PET scan - less radiation exposure not hampered by metallic artifacts

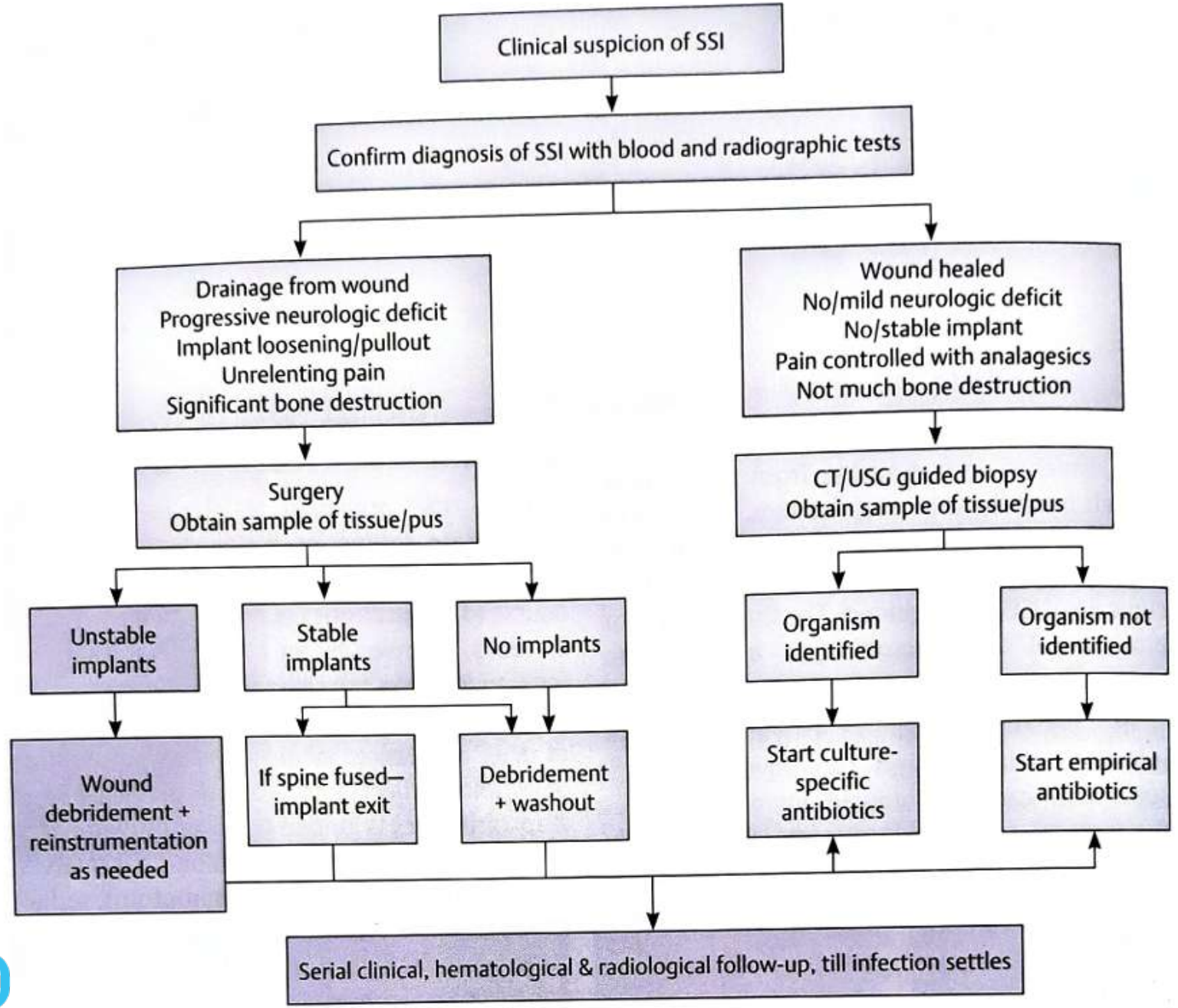


Fig. 4.3 Stepwise treatment algorithm for surgical site infection (SSI).

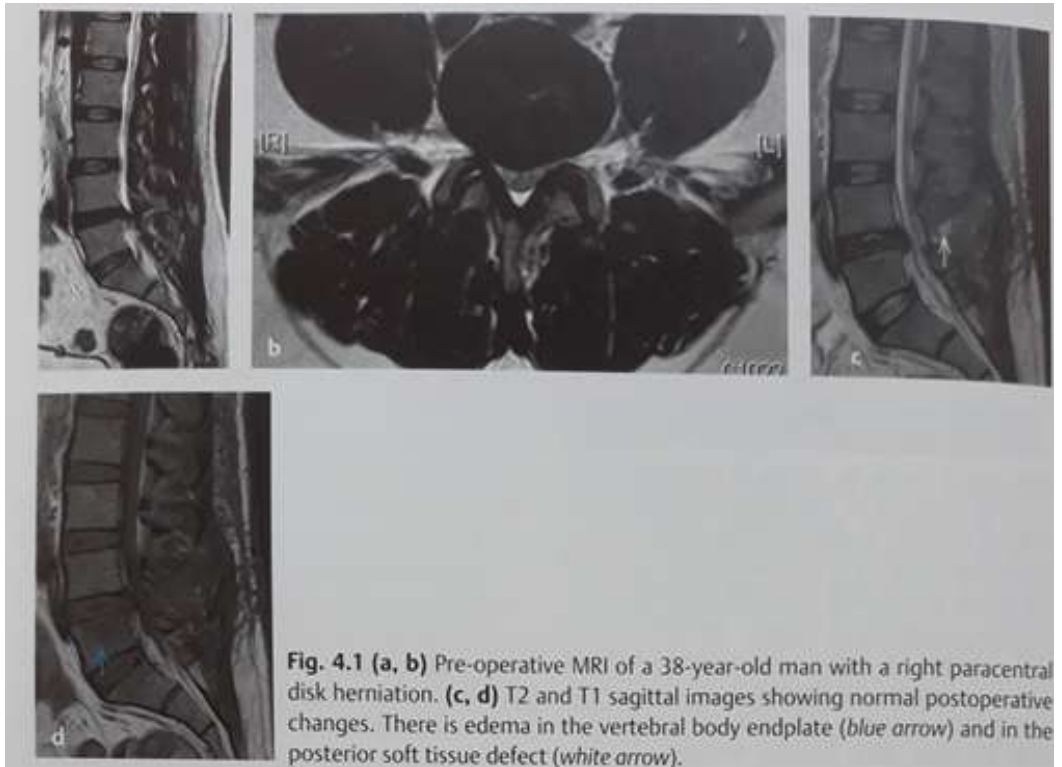


Fig. 4.1 (a, b) Pre-operative MRI of a 38-year-old man with a right paracentral disk herniation. **(c, d)** T2 and T1 sagittal images showing normal postoperative changes. There is edema in the vertebral body endplate (*blue arrow*) and in the posterior soft tissue defect (*white arrow*).

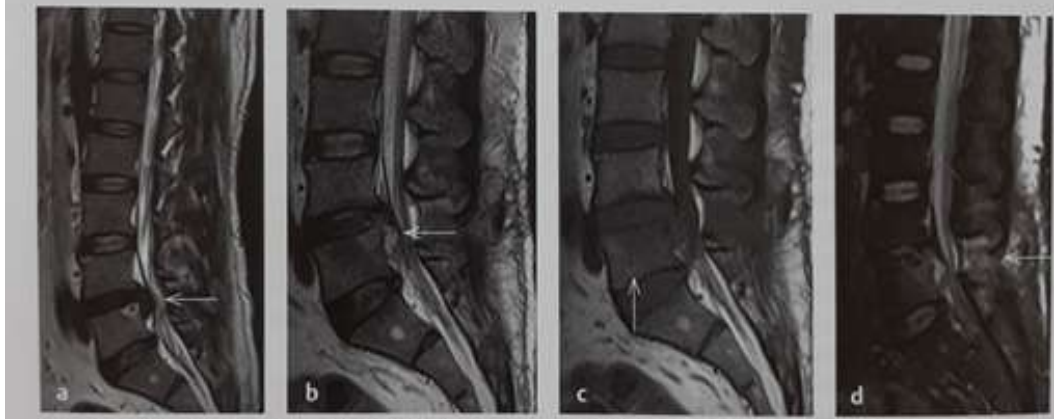


Fig. 4.2 (a) MRI of a 32-year-old man with a L4–L5 left-sided disk prolapse who underwent microdiscectomy. **(b)** Postoperative T2 weighted image showing a hyperintense signal posterior to the vertebral body. **(c)** Postoperative T1 weighted image showing a hypointense signal within the vertebral body reflecting bone edema. **(d)** Short tau inversion recovery image showing edema within the soft tissue posterior to the vertebral body and within the posterior soft tissues reflective of infection.

Fig. 4.4 (a) SSI with erythema wound dehiscence and exposed implant. **(b)** Wound debridement done. Necrotic tissue removed and bed has been made healthy to receive the vacuum dressing. **(c)** Vacuum dressing applied. Note the sterile foam filling the wound as well as the waterproof occlusive dressing. The suction tubing is attached below the dressing. **(d)** Wound ready for secondary closure. Implant has been retained. **(e)** Wound closed secondarily.

Fig. 4.7 (a) Postoperative site with multiple discharging sinuses. **(b)** Postoperative X-rays showing laminectomy defects at L4 and L5 with paradiscal erosions at these levels. **(c)** MRI showing hyperintense signals within the vertebral bodies with an epidural abscess posteriorly and hyperintense signal within the posterior soft tissues. **(d)** Postcontrast MRI demonstrating peripheral enhancement. **(e)** Plain radiographs following debridement, decompression and stabilization with interbody fusion.

Fig. 4.20 **(a)** Skin incision with implant exposed. **(b)** Wound debridement. **(c)** Latissimus dorsi flap. **(d)** 3-month postoperative follow-up.