

Spine Surgery: Operative & Post-Operative Management of Degenerative Disorders

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Course Overview

“Spine Surgery: Operative & Post-Operative Management of Degenerative Disorders” is a webinar for rehabilitation professionals that presents contemporary information about operative and post-operative management of orthopedic disorders of the spine. This course includes a review of current peer-reviewed literature relating to various vertebral decompressive/stabilizing surgical interventions.

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Course Rationale

The purpose of this course is to provide rehabilitation professionals with an understanding of current trends in surgical procedures used to manage non-traumatic orthopedic spinal compressive disorders. The primary emphasis is comparative analysis of contemporary surgical techniques for the cervical, thoracic, and lumbar regions.

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Goals and Objectives

1. List and identify common anatomical structures of the spine.
2. Distinguish degenerative and non-traumatic spinal pathologies.
3. Compare methods of intraoperative neurophysiological monitoring.
4. Describe decompression and stabilization surgical procedures for the cervical and lumbar spine.
5. Describe methods of thoracic spine sagittal plane balancing.
6. Distinguish different types of bone graft substitutes.
7. Identify the role of bone stimulators as an adjunct to surgical management.
8. Identify post-surgical considerations following spine surgery.
9. Recognize the role of post-operative braces for the spine.
10. Identify emerging surgical techniques for the spine.

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Disclaimer

Application of concepts presented in this webinar is at the discretion of the individual participant in accordance with federal, state, and professional regulations.

No conflict of interest exists for the presenter or provider of this course.

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Course Outline and Schedule



Topic	Time
Spine Anatomy and Arthrokinematics	0:00-0:10
Spine Pathologies	0:11-0:25
Intraoperative Neurophysiological Monitoring	0:26-0:35
Bone Graft and Substitutes	0:36-0:45
Bone Stimulators	0:46-0:50
Interactive Discussion of Clinical Applications	0:51-1:00
Cervical Anterior and Posterior Fusion	1:01-1:10
Post-Surgical Considerations	1:11-1:25
Thoracic Procedures	1:26-1:35
Post-Surgical Considerations	1:36-1:40
Lumbar Decompression	1:41-1:50
Interactive Discussion of Clinical Applications	1:51-2:00
Lumbar Interbody Fusion	2:01-2:15
Post-Surgical Considerations	2:16-2:20
Total Disc Replacement	2:21-2:25
Vertebroplasty and Kyphoplasty	2:26-2:30
Rehabilitation Considerations	2:31-2:45
Emerging Surgical Techniques	2:46-2:50
Interactive Discussion of Clinical Applications	2:51-3:00

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Course Post Test

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Spine Anatomy

- Functional unit of the spine is composed of two adjacent vertebrae, intervertebral disc, connecting ligaments, and facet joints.
- Lamina is between spinous and transverse process.
- Pedicle notches create intervertebral foramen.
- Uncovertebral joints in cervical spine limit lateral movement.



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Spine Ligaments

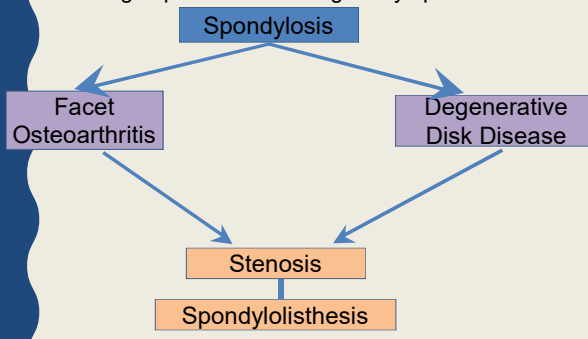
- Posterior longitudinal ligament runs along posterior aspect of vertebral body inside spinal canal.
- Ligamentum flavum connects lamina of adjacent vertebrae inside spinal canal.

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Spondylosis

- General term for degenerative changes of the spine leading to pain and neurological symptoms.



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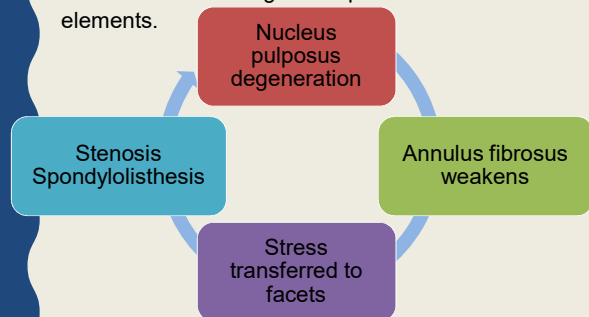
graph TD
    S[Spondylosis] --> FO[Facet Osteoarthritis]
    S --> DD[Degenerative Disk Disease]
    FO --> St[Stenosis]
    DD --> St
    St --> SO[Spondylolisthesis]
  
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Degenerative Disc Disease (DDD)

- Precipitating factors contribute to structural deterioration resulting in compression of neural elements.



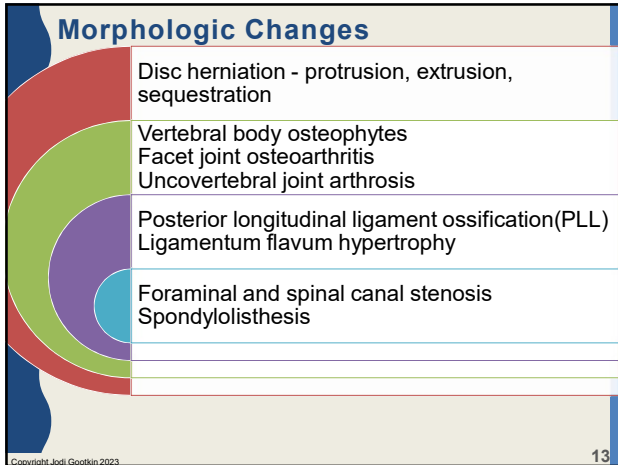
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graph TD
    NP[Nucleus pulposus degeneration] --> AF[Annulus fibrosus weakens]
    AF --> ST[Stress transferred to facets]
    ST --> SS[Stenosis Spondylolisthesis]
    SS --> NP
  
```

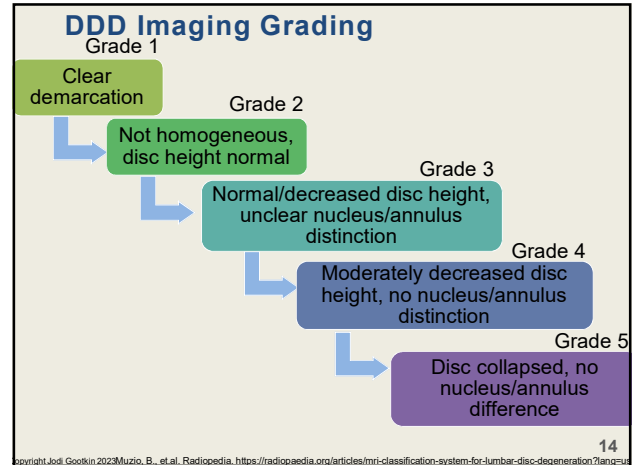
Copyright Jodi Gootkin 2023 Kushchayev, S., et al., (2018). ABCs of the degenerative spine. Insights into imaging, 9(2), 253–274.

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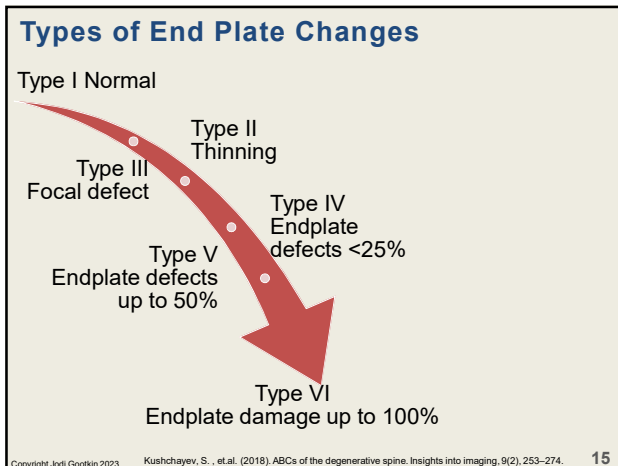
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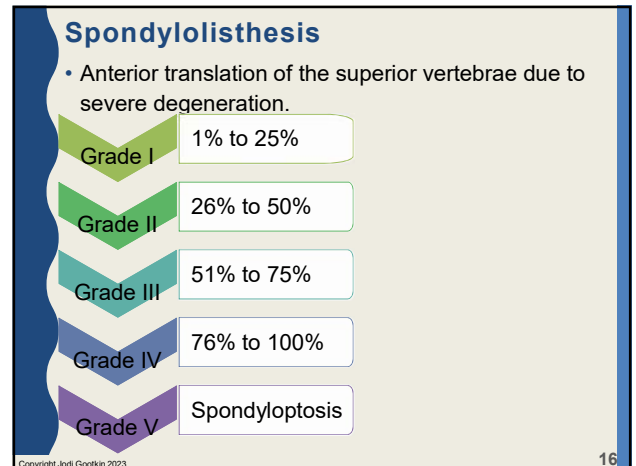
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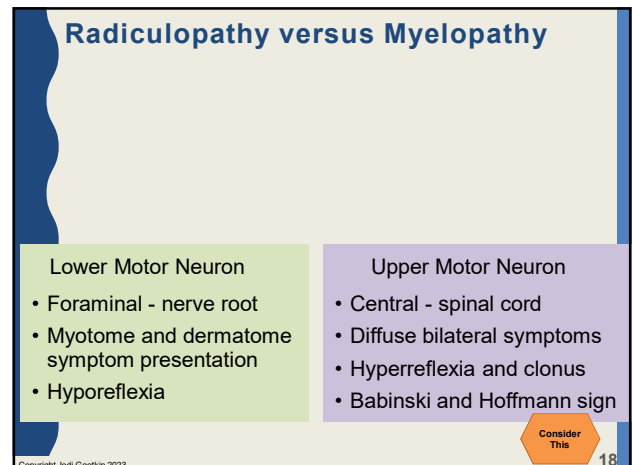
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- ### DDD Clinical Presentation
- Pain, sensory, motor and coordination deficits
 - Cauda equina compression presents as urinary retention, urinary and/or fecal incontinence, saddle anesthesia, and sexual dysfunction
 - Myelopathy and radiculopathy
 - Neurogenic claudication
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Neurogenic Claudication

Peripheral Vascular Claudication	Neurogenic Claudication
Abnormal vascular studies and pulses	Mechanical cord compression and/or ischemia
Greater leg pain	Normal peripheral pulses
Pain relieved with rest	Greater back pain
	Pain relieved with trunk flexion

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Deer, T., et al. (2019). A review of lumbar spinal stenosis with intermittent neurogenic claudication: disease and diagnosis. Pain medicine, 20(Supplement_2), S32-S44. Copyright Jodi Gootkin 2023

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Components of Spine Surgery

Exposure	Approach	Structures	Instrumentation
Open, minimally invasive, full endoscopic, percutaneous	Posterior, anterior, transforaminal, etc.	Fused or disk/bony tissue removed	Implants, devices, hardware

Wu PH, Kim HS, Jang J-T. Intervertebral Disc Diseases PART 2: A Review of the Current Diagnostic and Treatment Strategies for Intervertebral Disc Disease. International Journal of Molecular Sciences. 2020; 21(6):2135. Copyright Jodi Gootkin 2023

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Intraoperative Neurophysiologic Monitoring (IONM)

- Technology permits assessment of spinal cord function during surgery to avoid motor and sensory complications.
- Real-time feedback provides the surgeon with awareness of neural pathway integrity for corrective action.

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Types of IONM

	Somatosensory Evoked Potentials	Transcranial Motor Evoked Potentials	Triggered Electromyography
Type	Sensory	Motor	Nerve root
Stimulus	Peripheral	Spinal cord or motor cortex	Pedicle screw
Response	Cortex	Muscle	Muscle

Charalampidis, A., et al. (2020). The Use of Intraoperative Neurophysiological Monitoring in Spine Surgery. Global spine journal, 10(1 Suppl), 104S-114S. Copyright Jodi Gootkin 2023

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Spinal Instrumentation

- Stabilization
 - Plates
 - Pedicle screws and rod constructs
- Restore height
 - Interbody Cage
 - Polyetheretherketone (PEEK)
 - Titanium
 - Artificial Disc

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Bone Graft

- Autografts are the gold standard for arthrodesis.
- Allografts act as a scaffolding.

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Bone Graft Substitutes

- Demineralized bone matrix (DBM) derived from allografts contains a collagen matrix and growth factors offering osteoinductive and osteoconductive properties.
- Typically combined with other types of grafting.

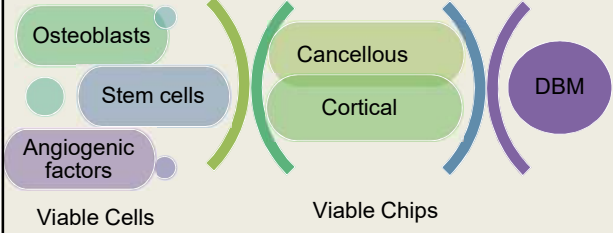
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Copyright Jodi Gootkin 2023. Cohen, J., et al. (2021). Allografts and Spinal Fusion. International Journal of Spine Surgery, 15(1), 68-93.

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Bone Graft Substitutes Continued

- Cellular bone matrix is an allograft product that mimics all critical properties of autographs eliminating the complications associated with harvesting.



Lin, C., et al. (2020). Comparing cellular bone matrices for posterolateral spinal fusion in a rat model. JOR spine, 3(2), e1084.
Diaz, R., et al. (2021). Investigating the efficacy of allograft cellular bone matrix for spinal fusion: a systematic review of the literature. Neurological Science, 50(6), F11.

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Grafting Complications

- Autograft
 - Donor site for infection, bleeding, and sensory deficits.
- Allograft
 - Infections

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Bone Growth Stimulator (BGS)

- Augment surgical management in patients at risk for pseudarthrosis following fusion.

- Internal**
 - During surgery
 - Lead in fusion substrate, direct current stimulation
- External**
 - Immediately post operative or later application
 - Skin electrodes, capacitive coupling (CC)
 - Coils in brace, pulsed electromagnetic field (PEMF) or combined magnetic field (CEMF)

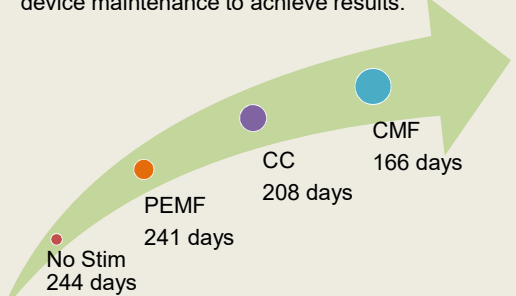
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BGS Considerations

- Encourage compliance with wearing schedule and device maintenance to achieve results.



Elsabeh R., et al. (2020) Increased Spinal Lumbar Fusion with Combined Magnetic Field (CMF) Bone Growth Stimulation. J Orthop Surg Tech 3(1):84-91

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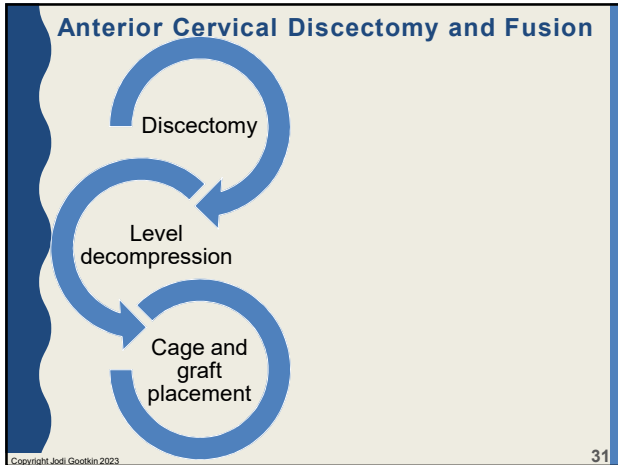
Spine Surgical Procedures

- Cervical
 - Anterior Cervical Discectomy and Fusion
 - Posterior Cervical Fusion
- Thoracic
 - Traditional Growing Rods
 - Vertical Expandable Prosthetic Titanium Rib
 - Magnetically Controlled Growing Rods
 - Vertebral Body Tethering
- Lumbar
 - Lumbar Decompression
 - Lumbar Interbody Fusion
- Total Disc Replacement

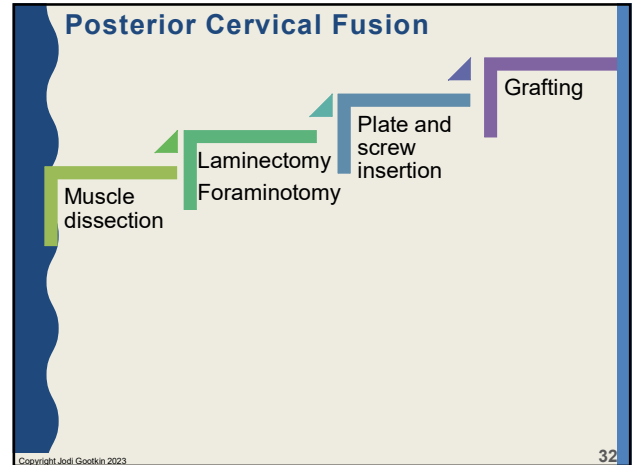
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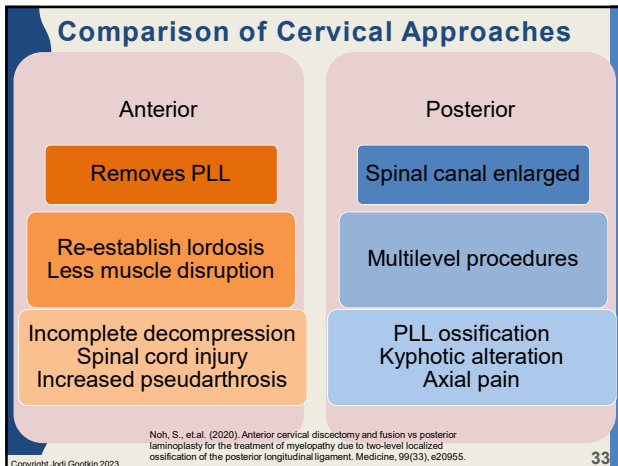
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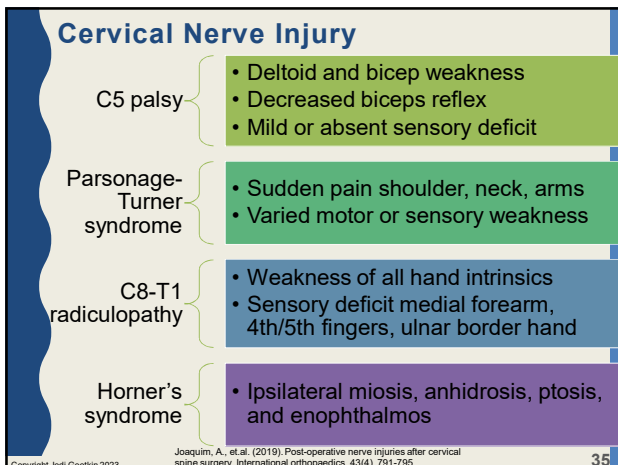
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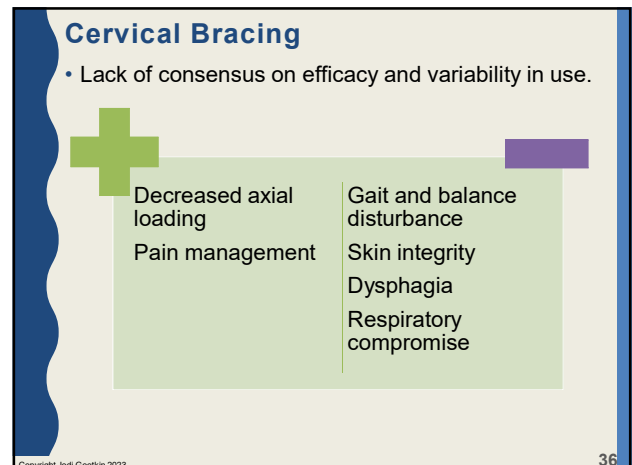
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- ### Cervical Surgery Complications
- Dysphagia – most common complication
 - Laryngeal nerve palsy
 - Esophageal perforation
 - Retropharyngeal abscess
 - Retropharyngeal hematoma
 - Nerve injury
- Epstein N. E. (2019). A Review of Complication Rates for Anterior Cervical Discectomy and Fusion (ACDF). *Surgical neurology international*, 10, 100.
- Perrone, O. et al. (2017). Pharyngo-esophageal perforation following anterior cervical discectomy and fusion: management and results. *European Journal of Cardio-Thoracic Surgery*, 51(1), 160-165.
- Song, K. J., Choi, B. W., Lee, D. H., Lim, D. J., Oh, S. Y., & Kim, S. S. (2017). Acute airway obstruction due to postoperative retropharyngeal hematoma after anterior cervical fusion: a retrospective analysis. *Journal of orthopaedic surgery and research*, 12(1), 1-7.
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Cervical Bracing Outcomes

Outcome

- 5-8 weeks of wearing - most significant improvement of neck disability index (NDI) score
- 9-12 weeks of wearing - new axial symptom development

Equivalent quality of life outcomes

- Not braced - longer length of stay, increased ER visits

Worse early NDI scores with bracing

- Focal kyphosis and disc space loss without bracing
- No significant difference in fusion rate or clinical outcomes

Qian, Y., Yu, Z., Liu, Z., Duan, W., Zhao, Z., Zheng, H., & Jian, F. (2020). Optimal Time Period of Wearing Protective Collar After Anterior Cervical Discectomy and Fusion. Caplan, I. et al. (2020). The Utility of Cervical Spine Bracing As a Postoperative Adjunct to Multilevel Anterior Cervical Spine Surgery. International journal of spine surgery, 14(2), 151-157. Elkazaz, M., et al., (2020). Cervical Intervertebral Cages: Past, Present, Innovations, and Future Trends with Review of the Literature. Egyptian Spine Journal, 35(1), 2-29.

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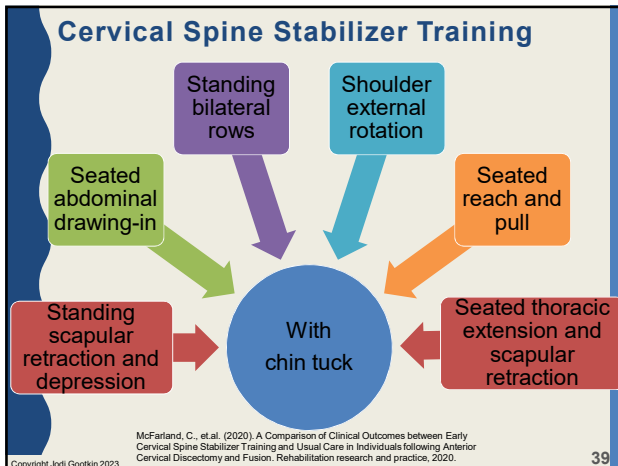
Post-Surgical Interventions

- Nonpharmacologic pain management
- Walking program
- Breathing exercises
- Activity restrictions
- Postural training
 - Avoid cervical extension
 - Deep cervical flexors and cervical multifidi

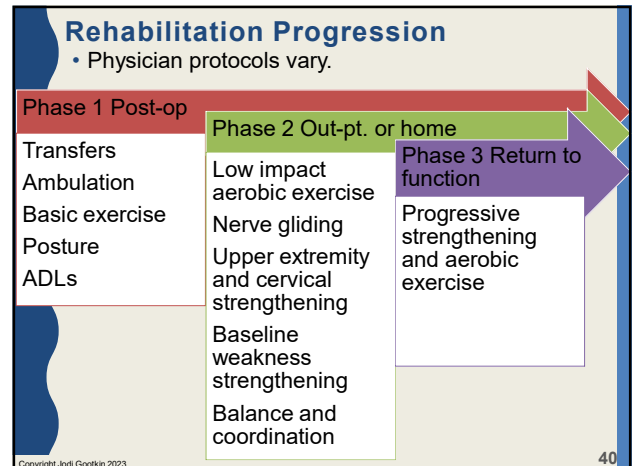
Coronado, R., et al. (2020) Early Self-directed Home Exercise Program After Anterior Cervical Discectomy and Fusion. SPINE, 45 (4), 217-225

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Thoracic Procedures For Scoliosis

- Adolescent idiopathic scoliosis (AIS) gold standard is fusion.
- Early onset scoliosis trend is growth friendly strategies.

Adult

- Fusion
- Osteotomy
- Vertebral resection

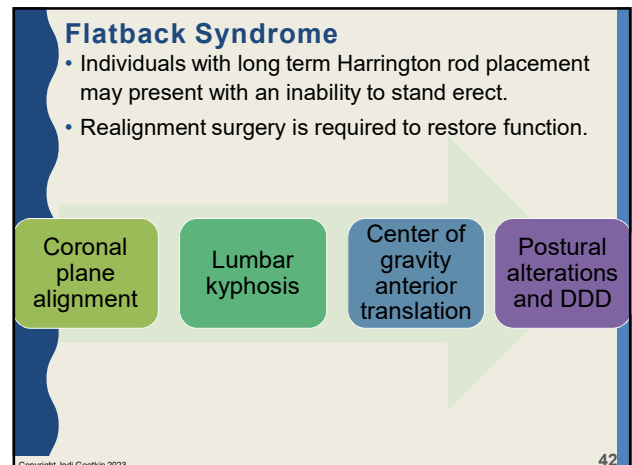
Pediatrics

- Fusion
- Hemivertebra resection
- Traditional growing rods
- Vertical expandable prosthetic titanium rib
- Magnetically controlled growing rod
- Vertebral body tethering

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Traditional Growing Rods

- Distraction-based spinal growth modulation rods require additional procedures for lengthening during the child's development.

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Vertical Expandable Prosthetic Titanium Rib (VEPTR)

- Progressive curvature may lead to the development of thoracic insufficiency syndrome (TIS).
 - Thoracic volume is structurally decreased and asymmetrical impairing ventilatory capacity.
- Devices attached to ribs and spine may have high complication rates.

Petro-Garcia, A., et al. (2021) Early Complications in Vertical Expandable Prosthetic Titanium Rib and Magnetically Controlled Growing Rods to Manage Early Onset Scoliosis. International Journal of Spine Surgery, 15(2), 368-375. Copyright Jodi Gootkin 2023

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Magnetically Controlled Growing Rod (MCGR)

- Pedicle screws and hooks anchor a telescoping rod with an external remote to rotate magnet for lengthening.
- Minimizes additional surgery for lengthening, but high rate of mechanical failure.

USFDA. (2021). Potential Concerns with NuVasive MAGEC System Implants - FDA Safety Communication <https://www.fda.gov/medical-devices/safety-communications/potential-concerns-nuvasive-magec-system-implants-fda-safety-communication>

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Vertebral Body Tethering

- Non-fusion spinal device designed to prevent spinal curve progression and avoid spinal fusion.
- A polymer cord is attached to bone anchors and screws on the side of the curve.
- Tension encourages spine alignment as individual grows.

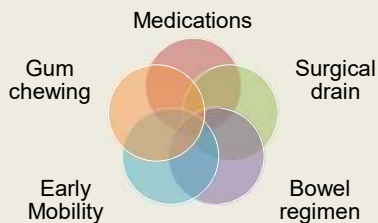
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Thoracic Post-Surgery Considerations

- Orthostatic hypotension may occur.
- Monitor for gastrointestinal complications.
- Address pulmonary function.



Yang, Y., et al. (2021). Orthostatic Hypotension Following Posterior Spinal Fusion Surgeries for Spinal Deformity Correction in Adolescents: Prevalence and Risk Factors.
Fletcher, N., et al. (2017). Development of consensus-based best practice guidelines for postoperative care following posterior spinal fusion for adolescent idiopathic scoliosis. Spine, 42(9), E547-E554.

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Lumbar Surgical Decompression

- Discectomy
 - Full or partial disc removal
- Laminectomy
 - Lamina, facet joints, ligaments
- Laminotomy
 - Portion of lamina and ligament
- Foraminotomy
 - Enlarges intervertebral foramen

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Full-Endoscopic Lumbar Discectomy (FELD)

- Less neuromuscular trauma and alteration to bony anatomy.
- Transforaminal (TELD) and interlaminar (IELD) approaches utilize natural anatomical entry into spinal canal.

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FELD Outcomes

Procedure	Outcome
Transforaminal vs. microdiscectomy	Pain and disability outcomes similar. TELD shorter hospital stay
Transforaminal longitudinal review	Pain, function, satisfaction improved long-term 5 years
FELD obese vs. non-obese adolescents	Comparable function and hospital stay

Gibson, J. A., Subramanian, A. S., & Scott, C. E. (2017). A randomised controlled trial of transforaminal endoscopic discectomy vs microdiscectomy. *European spine journal*, 26(3), 847-856.
 Yu, H., et al. (2021). Evaluation of full-endoscopic lumbar discectomy in the treatment of obese adolescents with lumbar disc herniation: a retrospective study. *BMC Musculoskeletal Disorders*, 22(1), 1-9.
 Ahn, Y., et al. (2018). Five-year outcomes and predictive factors of transforaminal full-endoscopic lumbar discectomy. *Medicine*, 97(48).

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Lumbar Interbody Fusion (LIF)

- Procedure to restore intervertebral space and stabilize segments.

Timeline of LIF evolution:

- 1800s: Laminectomy
- 1911: Spinous process bridge and wiring
- 1914: Added bone graft
- 1930-40s: Facet screws, different approaches
- 1932: Discectomy
- 1955: Harrington rod
- 1973: Endoscopic discectomy
- 1980-90s: Pedicle and interbody devices

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LIF Approaches

Lumbar Interbody Fusion (LIF) approaches:

- Anterior Lumbar Interbody Fusion (ALIF)
- Lateral Lumbar Interbody Fusion (LLIF)
- Extreme Lateral Interbody Fusion (XLIF)
- Posterior Lumbar Interbody Fusion (PLIF)
- Transforaminal Lumbar Interbody Fusion (TLIF)

Mobbs, R., et al. (2015). Lumbar interbody fusion: techniques, indications and comparison of interbody fusion options including PLIF, TLIF, MLTIF, OLIF/ATP, LLIF and ALIF. *Journal of spine surgery (Hong Kong)*, 1(1), 2-18.

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Anterior Approach - ALIF

- Direct disc access.
- Restores disc height and sagittal alignment.
- Challenges with visceral structures.
- Greater vascular complications.

Steps of Anterior Approach - ALIF:

- Discectomy
- End plate preparation
- Interbody cage
- Graft
- Pedicle screws

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Lateral Approach – LLIF and XLIF

- Minimizes neuromuscular and abdominal structure trauma.
- Psoas and lumbar plexus injury
- Vascular structures to avoid
- Not for patients with prior retroperitoneal surgery.

Epstein N. E. (2016). Extreme lateral lumbar interbody fusion: Do the cons outweigh the pros?. *Surgical neurology international*, 7(Suppl 25), S692-S700.

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Posterior Approaches – PLIF and TLIF

- Low complication rate
- Iatrogenic nerve and muscle injury

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    graph TD
      A[PLIF – Bilateral  
TLIF – Unilateral  
Laminectomy  
Facetectomy] --> B[Ligament  
removal]
      B --> C[Discectomy]
      C --> D[End plate  
preparation]
      D --> E[Interbody  
cage]
      E --> F[Graft]
      F --> G[Pedicle  
screws]
  
```

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Enhanced Recovery After Surgery (ERAS)

- Standardized multimodal care including early mobilization to optimize recovery.

Pre-op	<ul style="list-style-type: none"> • Education • Carbohydrate loading • Modified fasting
Peri-op	<ul style="list-style-type: none"> • Analgesia • Blood loss • Fluids • DVT and infection prophylaxis • Catheter and surgical drain sparing
Post-op	<ul style="list-style-type: none"> • Multimodal analgesia • Early mobilization • Early nutrition

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ERAS Spine Outcomes

Cohort	Outcome
Lumbar fusion	Shorter PCA and opioid use
Microdiscectomy and fusion	Decreased length of stay and adverse events without increased readmissions
Cervical or lumbar minor and major procedures	Reduced length of stay and opioid use

Soffin, E., et al. (2020). Enhanced Recovery after Lumbar Spine Fusion: A Randomized Controlled Trial to Assess the Quality of Patient Recovery. Anesthesiology, 133(2), 350-363.
Slaarjes, V., et al. (2019). Improving recovery after elective degenerative spine surgery: 5-year experience with an enhanced recovery after surgery (ERAS) protocol. Neurosurgical focus, 46(4), E7.
Tong, Y., et al. (2020). Enhanced Recovery After Surgery Trends in Adult Spine Surgery: A Systematic Review. International Journal of Spine Surgery, 14(4), 623-640.

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Lumbar Bracing

- Consensus is lacking on use and benefits.

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Lumbar Bracing Outcomes

Procedure	Outcome
PLIF, TLIF, IELD trials bracing vs. control	No difference in pain and disability levels
TLIF bracing vs. control	No difference in complications or fusion rates
Survey of Surgeons	More than half did not prescribe bracing

Nassi, D., et al. (2020). The efficacy of postoperative bracing after spine surgery for lumbar degenerative diseases: a systematic review. European Spine Journal, 29(2), 321-331.
Ma, H., et al. (2021). Postoperative spinal orthosis may not be necessary for minimally invasive lumbar spine fusion surgery: a prospective randomized controlled trial. BMC Musculoskeletal Disorders, 22(1), 1-7.
Pathak, N., et al. (2021). Postoperative bracing practices after elective lumbar spine surgery: A questionnaire study of US spine surgeons. North American Spine Society Journal (NASSJ), 5, 100055.

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Post-Surgical Interventions

- Nonpharmacologic pain management
- Early ambulation and walking program
- Activity restrictions
- Neutral spine control
- Abdominal bracing exercises

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Rehabilitation Progression

- Physician protocols vary.

Phase 1 Post-op

- Transfers
- Ambulation
- Basic exercise
- Posture/neutral spine
- ADLs

Phase 2 Out-pt. or home

- Leg stretching
- Lumbar stabilization
- Baseline weakness strengthening
- Nerve gliding
- Balance

Phase 3 Return to function

- Progressive strengthening and aerobic exercise

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Total Disc Replacement

- Advantages compared to fusion:
 - Retains ROM
 - Bone graft not utilized
 - Less risk of adjacent segment disease
 - Earlier ROM post surgery

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Cervical Disc Replacement

- Intractable cervical radicular pain or myelopathy with failed conservative management OR severe progressive symptoms of compression
- AND imaging nerve root or spinal cord compression
- AND DDD from C3 to C7
- AND free from absolute contraindications including extreme obesity and osteoporosis.

Medicare Coverage Database. LCD Cervical Disc Replacement (L38033).
<https://www.cms.gov/medicare-coverage-database/details/lcd-details.aspx?lcdid=38033&ver=9&keyword=cervical%20artificial%20disc&keywordType=start&areaid=all&docType=NCA,CAL,NCD,MEDCAC,TA,MCD,6,3,5,1,F,P&contractOption=all&sortBy=relevance&bc=AAAAAQAQAAAA&KeyWordLookUp=Doc&KeyWordSearchType=Exact>

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Lumbar Disc Replacement

- National coverage determination is that lumbar artificial disc replacement is a non-covered service for beneficiaries over 60 years of age.
- For beneficiaries age 60 years and younger, the NCD leaves the determination to local Medicare Administrative Contractors (MACs).

Medicare Coverage Database. Local Coverage Determination (LCD) Lumbar Artificial Disc Replacement (L37826) <https://www.cms.gov/medicare-coverage-database/details/lcd-details.aspx?lcdid=37826&ver=21&keyword=lumbar%20artificial%20disc&keywordType=starts&areaid=all&docType=NCA,CAL,NCD,MEDCAC,TA,MCD,6,3,5,1,F,P&contractOption=all&sortBy=relevance&bc=AAAAAQAQAAAA&KeyWordLookUp=Doc&KeyWordSearchType=Exact>

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Vertebroplasty

- Injection of bone cement into the crushed vertebral body through posterior cannulas to stabilize loose bone fragments.

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Kyphoplasty

- Expansion of the compressed vertebral cavity to restore lost height allowing improved sagittal spinal alignment.

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Rehabilitation Considerations

- In addition to surgery specific considerations, general areas to address for all post-surgical spine patients.
 - Surgical complications
 - Medication and diet
 - Tobacco use
 - Mobility restrictions
 - Physical activity level

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Spine Surgery Complications

- Incision and drain care
- Sleep apnea
 - Deep vein thrombosis and pulmonary complications
- Worsening radicular symptoms
- Bowel and bladder incontinence
- Pseudarthrosis
- Adjacent segment disease

Chung, A. et al. (2018). Obstructive Sleep Apnea in Elective Spine Surgery: National Prevalence and Inpatient Outcomes. Global spine journal, 8(6), 550-556.

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Perioperative Vision Loss

- Operative positioning combined with risk factors may result in ischemic optic neuropathy.

```

    graph TD
      A[External eye compression] --> B[Intraocular pressure increase]
      B --> C[Retinal artery occlusion]
      C --> D[Impaired venous drainage]
      D --> E[Ischemia]
  
```

Apfelbaum, J. et al. (2019). Practice advisory for perioperative visual loss associated with spine surgery 2019: an updated report by the American society of anesthesiologists task force on perioperative visual loss, the North American neuro-ophthalmology society, and the society for neuroscience in anesthesiology and critical care. Anesthesiology, 130(11), 13-30.

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Medications and Diet

- Prescribed pain medications and avoid anti-inflammatories
- Constipation
- Adequate protein intake
- Avoid driving while taking narcotics.

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Low Body Mass Index (BMI)

- Underweight patients may be at increased risk for post-surgical complications.

```

    graph LR
      A[Nutritional or metabolic conditions] --> B[Impaired responses]
      B --> C[Complications]
  
```

Altered protein levels
Osteoporosis

Impaired responses

- Immune response
- Clotting
- Bone healing

Complications

- Bleeding
- Infection
- Adverse events

Ottosen, T., et al. (2021). Underweight patients are an often under looked "At risk" population after undergoing posterior cervical spine surgery. North American Spine Society Journal (NASSJ), 5, 100041.

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Tobacco Use

- Increased risk of post-surgical incision necrosis and dehiscence, delayed wound healing, and infection.
- Significantly increased risk of pseudarthrosis and surgical adjacent segment disease.

```

    graph LR
      A[Tobacco Use] --> B[Endothelial damage]
      B --> C[Impaired osteoblasts and phagocytosis]
      C --> D[Platelet aggregation]
  
```

Endothelial damage

Impaired osteoblasts and phagocytosis

Platelet aggregation

Khurana V. G. (2021). Adverse impact of smoking on the spine and spinal surgery. Surgical neurology international, 12, 118.

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Mobility Restrictions

- Postural alignment
- Log rolling
- Sitting and sleeping position
- Lifting restrictions
- Adaptive equipment
- Ergonomics

NO
Bending
Lifting
Twisting

Consider This

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Physical Activity Level

- Long term functional gains do not appear to correlate to physical activity level.

Intervention	Outcome
Lumbar fusion	No change in physical activity from 6 weeks to 3 and 6 months but significant functional improvement
Lumbar or cervical surgery	Return to pre-op level at 12 weeks and improvement beyond uncommon. Depression associated with low activity level.

Coronado, R., et al. (2020). Early postoperative physical activity and function: a descriptive case series study of 53 patients after lumbar spine surgery. BMC Musculoskeletal Disorders, 21(1), 1-10.

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Emerging Techniques

- Monitoring technology
 - Skin Anchored Intra-operative Navigation
- Instrumentation
 - 3D printing
 - Interspinous process devices

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Skin Anchored Intra-operative Navigation

- Image guidance facilitating visualization with skin-anchored trackers providing anatomical reference points.
- Shorter operative time and low patient radiation exposure.

Vaishnav, A., et al. (2021). Technique, time demand, radiation exposure, and outcomes of skin-anchored intraoperative 3d navigation in minimally invasive posterior cervical laminoforaminotomy. Clinical Spine Surgery : A Spine Publication.

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3D Printing

- Trussed design provides light weight but strong implants.
- Custom fit and pressure distribution can contribute to strength of fusion.

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Interspinous Process Devices (ISP)

- Distract the spinous processes to unload the lumbar spine and provide stability.

<p>Interspinous</p> <ul style="list-style-type: none"> • Stand-alone device • Wings lock in place for decompression 	<p>Interlaminar</p> <ul style="list-style-type: none"> • After surgical decompression • Concurrent fusion (ILIF) Interlaminar Lumbar Instrumented Fusion
---	--

Faulkner, J., et al. (2021). Interspinous Process (ISP) Devices in Comparison to the Use of Traditional Posterior Spinal Instrumentation. Cureus, 13(3), e13886.

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Conclusion

- Technology advances allowing surgical approaches with less disruption of anatomical structures combined with rehabilitation strategies can improve quality of life for individuals with degenerative disc disease.

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1. Which statement best describes the uncovertebral joints?

- A. Located between lumbar levels 3 to 7
- B. Formed by superior and inferior facets
- C. Limit lateral movements of the cervical vertebrae
- D. Supported by ligamentum flavum

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2. What condition is an upper motor neuron lesion involving compression of the spinal cord?

- A. Blepharopathy
- B. Myelopathy
- C. Neuropathy
- D. Radiculopathy

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3. How does intraoperative neurophysiologic monitoring enhance surgical outcomes?

- A. Decreased hypoxic events through blood gas monitoring
- B. Reduce need for post-operative transfusions
- C. Sedation monitoring allowing lower levels of anesthesia
- D. Awareness of neural pathway integrity for corrective action

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4. What is the osteoinductive and osteoconductive material derived from allografts that is used during spinal fusion surgery?

- A. Bone morphogenetic proteins
- B. Demineralized bone matrix
- C. Iliac crest bone graft
- D. Polyetheretherketone cage

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5. Which of the following statements accurately describes direct current bone stimulation?

- A. Recommended in low risk pseudarthrosis cases
- B. Enhances healing following discectomy
- C. Utilizes superficial electrodes adjacent to surgical site
- D. Inserted within fusion substrate

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6. What is the most common immediate post-operative complication following anterior cervical discectomy and fusion (ACDF)?

- A. Dysphagia
- B. Dyspnea
- C. Infection
- D. Thrombosis

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7. Which procedure is considered the gold standard surgical option to manage adolescent idiopathic scoliosis?

- A. Traditional growing rod
- B. Magnetically controlled growing rod
- C. Vertebral body tethering
- D. Fusion

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8. A greater risk of vascular complications exists with which lumbar fusion surgical approach?

- A. ALIF
- B. PLIF
- C. TLIF
- D. XLIF

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9. A patient presenting with intractable radiculopathy and _____ would be a candidate for total disk replacement.

- A. Extreme BMI
- B. Osteoporosis
- C. Myelopathy
- D. Only axial pain

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10. Following lumbar spine surgery patients should avoid what activities?

- A. ADLs
- B. BLTs
- C. LSSP
- D. TFRS

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