Cervical Revision Surgery

Understanding Why Prior Cervical Surgery May Fail — and What Can Be Done

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Cervical spine surgery — including anterior cervical discectomy and fusion (ACDF), posterior cervical fusion, and cervical disc replacement — reliably helps the majority of appropriately selected patients. However, a meaningful proportion will develop new or recurrent symptoms over time that require further evaluation and, in some cases, revision surgery.

The four most important causes of failure after cervical spine surgery are: **pseudoarthrosis and hardware failure** after ACDF, **iatrogenic cervical kyphosis and chin-on-chest deformity** after posterior fusion, **failed cervical disc replacement**, and **adjacent segment disease**. Each has a distinct mechanism, clinical presentation, and surgical solution. Dr. Caridi has specialized expertise in the diagnosis and correction of all four.

1. Pseudoarthrosis & Hardware Failure After ACDF

Pseudoarthrosis after ACDF at C5-C6. Anterior view shows absent bone bridge through the interbody space. Lateral X-ray demonstrates radiolucent gap; CT confirms absent bone bridging with sclerotic endplates.

What Is Cervical Pseudoarthrosis?

Pseudoarthrosis — literally "false joint" — occurs when the bone graft placed during ACDF fails to fully incorporate and create a solid bony bridge across the fused disc space. Instead of a rigid union, a fibrous non-union persists, allowing continued micro-motion at the operated level. This ongoing movement prevents healing, fatigues the hardware, and chronically irritates the adjacent nerve roots and spinal cord.

Why Does ACDF Fusion Fail?

- **Smoking** — the most potent modifiable risk factor. Nicotine directly impairs osteoblast function and reduces bone vascularity, dramatically increasing cervical pseudoarthrosis rates at every level
- **Multilevel fusion** — each additional level fused reduces the overall fusion rate; three- and four-level ACDFs carry significantly higher non-union rates than single-level procedures
- **Osteoporosis** — poor bone quality impairs graft incorporation and reduces screw and plate purchase in the vertebral bodies
- **Inadequate immobilization** — excessive early cervical motion prevents graft consolidation; a cervical collar may be required
- **Diabetes** — impairs the biology of bone healing and increases infection risk at every stage
- **Infection** — even low-grade wound or disc space infection disrupts normal fusion biology
- **Technical factors** — insufficient graft volume, inadequate endplate preparation, or improper cage/plate positioning

Hardware Failure After ACDF

When fusion fails, the cervical plate, screws, and cage are subjected to cyclic loading across a mobile non-union — the equivalent of repeatedly bending metal until it fractures. Hardware failure is nearly always a *consequence* of pseudoarthrosis, not an independent event:

- **Plate or screw loosening:** Radiolucent halos around screw heads on X-ray indicate toggling and loss of fixation; screws may back out into the esophagus or trachea — a rare but serious complication
- **Plate fracture:** The anterior cervical plate breaks under cyclical fatigue loading, indicating a mobile non-union beneath it
- **Cage subsidence:** The interbody cage sinks into the softened endplate, losing foraminal height and nerve root decompression — particularly in osteoporotic patients
- **Cage migration:** An unfused cage may migrate anteriorly, impinging on the esophagus, or posteriorly into the spinal canal

Symptoms & Diagnosis

Pseudoarthrosis typically presents months to years after surgery with return of neck pain, arm pain, or neurological symptoms:

- Persistent or recurrent neck pain, often mechanical in character
- Radicular arm pain, numbness, or tingling in the distribution of the nerve root at the operated level
- New or worsening myelopathy symptoms — hand clumsiness, gait imbalance, or upper extremity weakness — if cord compression recurs
- Pain that worsens with neck movement or activity

Key Diagnostic Studies:

- **CT scan** — gold standard; reveals absent bone bridging, sclerotic endplates, cystic changes, and hardware loosening
- **Flexion-extension X-rays** — demonstrate motion at the non-union; broken plates or displaced screws
- **MRI** — evaluates cord compression, residual foraminal stenosis, and epidural fibrosis at the operated level

Surgical Treatment

- **Posterior cervical fusion** with lateral mass or pedicle screws — the most common and reliable revision approach; adds rigid posterior fixation across the non-union to create a combined anterior-posterior construct and dramatically improves fusion rates
- **Anterior revision ACDF** — remove failed hardware, re-prepare endplates, place new cage and graft, revise plate and screws; used when posterior approach is not preferred
- **Bone stimulator** — external pulsed electromagnetic field device worn post-operatively to enhance bone healing

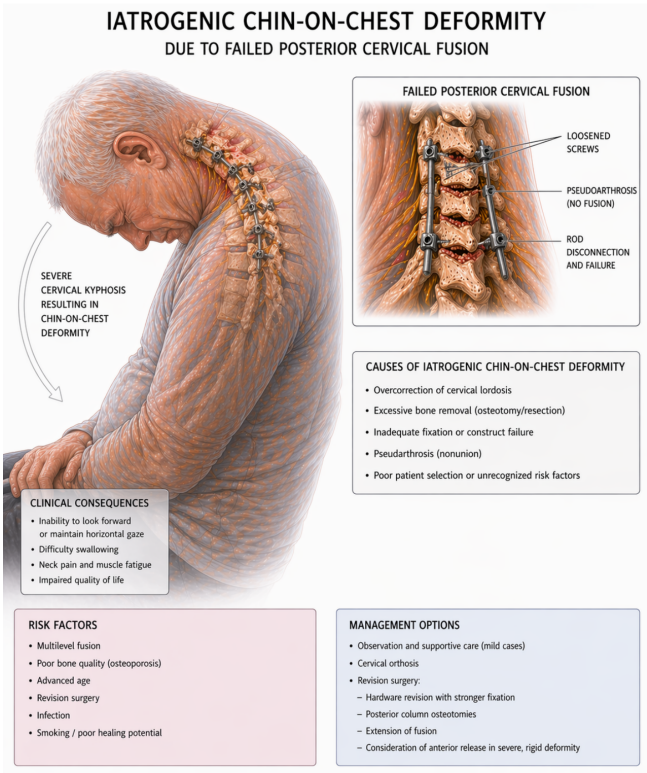
2. Iatrogenic Cervical Kyphosis & Chin-on-Chest Deformity

What Is Iatrogenic Cervical Kyphosis?

The normal cervical spine has a gentle forward curve called **cervical lordosis**. When this curve is lost or reversed — creating a kyphotic (forward-bending) alignment — the head shifts forward of its ideal position over the body. In mild forms this produces chronic neck pain and fatigue. In severe forms, the chin progressively approaches the chest, producing the devastating **chin-on-chest deformity** — an inability to look forward or maintain a horizontal gaze.

How Does Prior Surgery Cause This?

- **Overcorrection of cervical lordosis:** During posterior fusion, rods bent in excessive lordosis can paradoxically produce kyphosis if the posterior elements are also over-resected, destabilizing the posterior tension band
- **Excessive bone removal (laminectomy/osteotomy):** Aggressive removal of posterior elements — laminae, facet joints, spinous processes — eliminates the posterior tension band that maintains lordosis; the spine collapses into kyphosis under the weight of the head
- **Inadequate fixation or construct failure:** Loosened screws and disconnected rods (as shown in the illustration) cannot maintain the corrected alignment; progressive kyphosis develops as the construct fails
- **Pseudoarthrosis:** Failure of the posterior fusion to heal allows progressive deformity at the non-union site
- **Poor patient selection:** Osteoporosis, advanced age, prior radiation, or multilevel revision surgery significantly increase the risk of construct failure and deformity progression



Severe cervical kyphosis after failed posterior cervical fusion, producing chin-on-chest deformity. Failed posterior hardware shows loosened screws, pseudoarthrosis, and rod disconnection.

Clinical Consequences

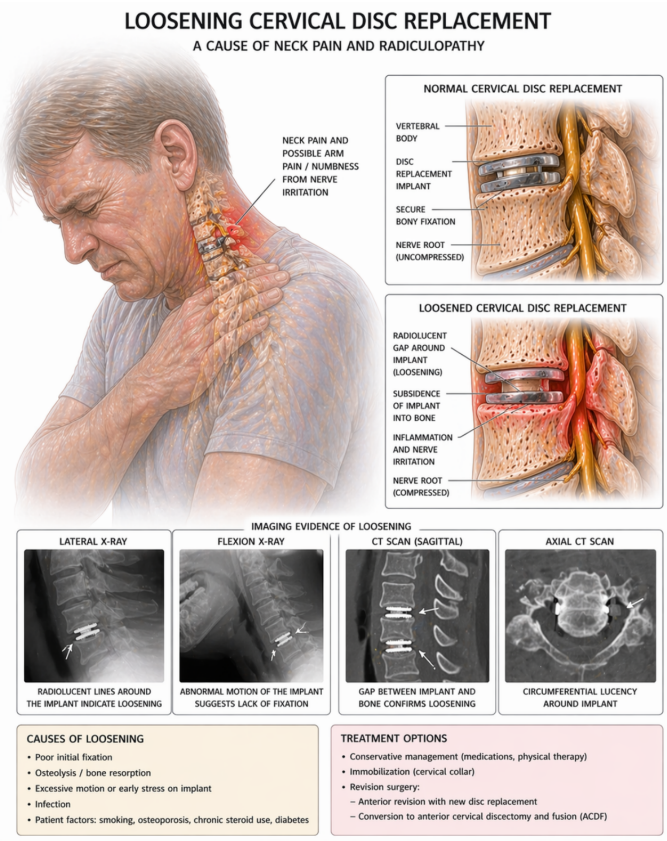
- Inability to look forward or maintain horizontal gaze — impacts driving, eating, social interaction, and reading
- Difficulty swallowing (dysphagia) — the chin compresses the airway and esophagus
- Severe neck pain and muscle fatigue from constant strain on the posterior musculature
- Spinal cord compression from the kyphotic deformity causing or worsening myelopathy — progressive hand weakness, gait instability
- Respiratory compromise in severe cases — the deformity can mechanically restrict breathing
- Profound impairment of quality of life — patients often cannot work, drive, or perform basic daily activities

Surgical Correction

Correction of severe cervical kyphosis is among the most technically challenging operations in spine surgery. The approach is tailored to the severity and rigidity of the deformity:

- **Posterior column osteotomies (PCO/Ponte):** Removal of posterior elements at one or more levels to allow the spine to be extended and re-lordosed; most appropriate for flexible or moderate kyphosis
- **Posterior cervical revision with stronger fixation:** Removal of failed hardware; replacement with larger-diameter rods, additional screw anchors, and occipital fixation if needed
- **Pedicle subtraction osteotomy (PSO):** Powerful three-column correction for rigid, severe deformity; can restore 20–30° of lordosis at a single level
- **Anterior release and fusion:** In rigid chin-on-chest deformity, an anterior approach to release contracted anterior structures may be required before posterior correction
- **Extension of fusion:** Long-segment posterior constructs typically extended to the upper thoracic spine (T2-T4) to avoid proximal junctional failure above the cervical fusion

3. Failed Cervical Disc Replacement (TDR)



Loosening cervical disc replacement: radiolucent gap around the implant, subsidence into bone, inflammation, and nerve root compression. Imaging evidence includes lateral X-ray, flexion X-ray, and sagittal/axial CT.

What Is a Cervical Total Disc Replacement?

Cervical total disc replacement (TDR) — also called cervical arthroplasty — is an alternative to ACDF in which the degenerated disc is removed and replaced with an artificial implant designed to preserve motion at that cervical level. The theoretical advantage over fusion is that maintained motion reduces stress on adjacent levels. TDR is FDA-approved for one- and two-level disease and produces excellent outcomes in appropriately selected patients.

How and Why TDR Fails

- **Implant loosening / subsidence:** The most common failure mode. The implant loses its secure bony fixation and begins to toggle within the disc space, creating a radiolucent gap around the implant on imaging and sinking into the softened endplate. Loosening causes ongoing inflammation, bone resorption, and nerve root compression.
- **Osteolysis / bone resorption:** Particulate debris from the articulating surfaces of the implant triggers an inflammatory response that resorbs surrounding bone — further destabilizing the construct.
- **Heterotopic ossification (HO):** Abnormal bone formation around the implant that progressively eliminates the intended motion — effectively converting the arthroplasty to an unintended fusion, with loss of the motion-preservation benefit.
- **Implant migration:** A loose TDR may displace posteriorly into the spinal canal, compressing the spinal cord or nerve roots, or anteriorly into the esophagus.
- **Infection:** Periprosthetic infection — though rare — causes rapid hardware failure and requires urgent implant removal.
- **Wrong patient selection:** TDR is contraindicated in significant osteoporosis, facet arthritis, instability, or prior fusion at the same level; when performed in these patients, failure rates increase.

Symptoms of TDR Failure

- New or recurrent neck pain — often different in character from pre-operative pain
- Arm pain, numbness, or weakness from nerve root compression by the loosened or migrated implant
- Myelopathy symptoms — hand clumsiness, gait imbalance — if the implant has migrated posteriorly and is compressing the spinal cord
- Dysphagia or throat discomfort if the implant is migrating anteriorly
- Pain with neck movement — particularly if the implant is loose and causing abnormal motion at the level

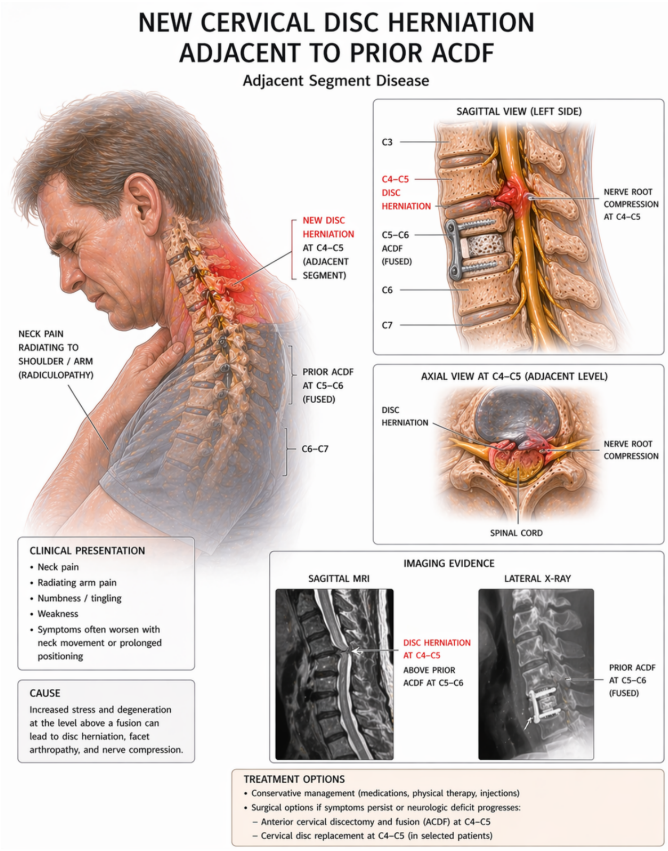
Diagnosis

- **CT scan** — demonstrates radiolucency around the implant, subsidence, bone resorption, and heterotopic ossification
- **Flexion-extension X-rays** — confirm abnormal motion at the implant level or paradoxical rigidity from extensive HO
- **MRI (with metal artifact reduction)** — evaluates cord and nerve root compression from the failed implant

Surgical Treatment of Failed TDR

- **Conversion to ACDF:** Removal of the failed disc replacement implant via an anterior approach and conversion to standard anterior cervical discectomy and fusion with a cage, bone graft, and plate — the most common revision strategy
- **Anterior revision with new TDR:** In carefully selected cases with implant loosening but intact bone stock and no HO, revision with a new arthroplasty implant may be considered
- **Combined anterior-posterior surgery:** Required when the failed TDR has caused instability or deformity necessitating additional posterior fixation

4. Adjacent Segment Disease & Failure



New disc herniation at C4-5 adjacent to a prior ACDF at C5-C6, compressing the C4-5 nerve root. Sagittal MRI confirms disc herniation; axial view demonstrates cord and nerve root compression at the adjacent level.

What Is Adjacent Segment Disease?

Cervical fusion eliminates motion at the operated level. The cervical spine must still move through its full range, however — and this motion is redistributed to the unfused segments immediately above and below the fusion. These adjacent levels experience increased intradiscal pressure, altered kinematics, and accelerated wear. Over time, this produces premature degenerative change — a process called **adjacent segment disease (ASD)**. When it becomes clinically symptomatic with pain or neurological deficits, it is termed **adjacent segment failure**.

What Develops at the Adjacent Level?

- **Disc herniation:** The disc adjacent to the fusion degenerates and herniates, compressing the nerve root at that level — producing a new pattern of arm pain and neurological deficit different from the original pre-surgical symptoms
- **Foraminal stenosis:** Osteophyte formation and facet hypertrophy at the adjacent level narrow the nerve root canal, causing progressive radiculopathy
- **Central stenosis / myelopathy:** Disc bulging, osteophytes, and ligamentum flavum hypertrophy at the adjacent level can narrow the central canal, compressing the spinal cord and producing or worsening myelopathy
- **Instability:** The adjacent segment may become hypermobile in compensation for the adjacent fused levels, producing pain and accelerating degeneration

Symptoms

Adjacent segment failure typically develops gradually, 2–10 or more years after the original fusion. Patients often describe a return of familiar symptoms, but in a slightly different pattern or level:

- Neck pain — often at a higher or lower level than the prior surgery
- New arm pain, numbness, or tingling in a dermatomal distribution corresponding to the adjacent nerve root — notably different from the original pre-surgical arm pain
- New or progressive hand weakness or myelopathy symptoms — difficulty with fine motor tasks, grip weakness, gait imbalance — indicating cord compression at the adjacent level
- Symptoms that worsen with neck movement or sustained positioning

Risk Factors

- Multilevel fusion — longer constructs impose greater stress on end-segment levels
- Pre-existing degeneration at adjacent levels at time of original surgery
- Sagittal malalignment — poor cervical lordosis increases adjacent level loading
- Older age and female sex

Diagnosis

- **MRI cervical spine** — demonstrates disc herniation, cord compression, foraminal stenosis, and myelomalacia at the adjacent level
- **CT scan / CT myelogram** — evaluates bony stenosis, osteophyte formation, and fusion integrity at the prior operative level
- **Standing cervical X-rays** — assess sagittal alignment, instability at adjacent levels, and fusion status
- **EMG/NCS** — helps distinguish adjacent segment nerve root compression from peripheral nerve or brachial plexus pathology

Surgical Treatment

- **Extension of fusion (ACDF):** The most common approach — extend the prior fusion one or more levels to include the symptomatic adjacent segment with a new discectomy, cage, and plate
- **Cervical disc replacement at adjacent level:** In carefully selected patients, TDR at the adjacent level may preserve motion and reduce the risk of further adjacent segment stress
- **Posterior foraminotomy:** A minimally invasive posterior approach to decompress a specific nerve root at the adjacent level without extending the anterior fusion — appropriate for soft disc herniations without instability
- **Combined anterior-posterior surgery:** When multiple levels are involved or deformity correction is needed alongside decompression

5. Evaluating Failure After Prior Cervical Surgery

A systematic evaluation is essential before any revision plan is made. Dr. Caridi performs a comprehensive assessment to precisely identify the cause and level of failure:

History & Neurological Examination

A detailed history of the prior surgery, post-operative course, and the timing and character of recurrent symptoms directs the evaluation. A complete neurological exam documents any new motor deficits, reflex changes, or sensory loss. Myelopathy is assessed with Hoffman's sign, clonus, tandem gait, and grip strength testing.

MRI Cervical Spine

The primary soft tissue imaging study. Evaluates cord compression, myelomalacia (cord signal change indicating injury), disc pathology at adjacent levels, epidural fibrosis, and the overall alignment of the cervical spine. Metal artifact reduction sequences improve visualization around prior hardware.

CT Scan / CT Myelogram

CT is the gold standard for assessing fusion integrity — demonstrating whether solid bone bridges the operated levels. It also evaluates hardware position, screw loosening, and bony anatomy for revision surgical planning. CT myelogram provides superior nerve root visualization when MRI is limited by hardware artifact.

Standing Cervical X-Rays (Flexion/Extension)

Full-length standing lateral and AP radiographs reveal overall cervical and cervicothoracic alignment, hardware integrity (broken plates, displaced screws), and fusion status. Dynamic flexion-extension views demonstrate motion at the fused or adjacent levels — key for diagnosing pseudoarthrosis and instability.

EMG / Nerve Conduction Studies

Electrodiagnostic testing helps localize the level of nerve dysfunction and distinguishes cervical radiculopathy from peripheral neuropathy, carpal tunnel syndrome, or brachial plexopathy — conditions that can coexist with or mimic cervical pathology.

DEXA Bone Density Scan

Bone quality assessment is essential before revision surgery. Significant osteoporosis influences implant selection, the need for cement augmentation of screws, and whether pre-operative anabolic therapy (teriparatide) is warranted to optimize fusion potential.

Laboratory Studies

ESR, CRP, and white cell count are measured when infection is suspected as a contributing cause. HbA1c guides diabetes optimization prior to revision surgery.

6. Risks of Cervical Revision Surgery

Revision cervical surgery carries substantially higher risks than primary procedures. Scar tissue from prior operations distorts anatomy, adherent structures increase the risk of injury to critical nearby structures, and prior hardware complicates the surgical approach. A thorough understanding of these risks is essential:

- **Spinal cord and nerve root injury:** The most consequential risk. Epidural fibrosis binds the dura and nerve roots to surrounding scar tissue. Intraoperative neuromonitoring (MEPs, SSEPs, EMG) is used throughout all revision procedures to protect neural function.
- **Injury to anterior cervical structures:** The esophagus, trachea, carotid artery, jugular vein, and recurrent laryngeal nerve (voice box nerve) lie immediately in front of the cervical spine. Prior anterior surgery creates adhesions that increase the risk of injury to all of these structures — hoarseness, dysphagia, and vascular injury are recognized risks of anterior revision.
- **Dural tear / CSF leak:** The dura is frequently adherent to prior scar in the posterior epidural space. Inadvertent durotomies are repaired immediately but may prolong recovery.
- **Re-pseudoarthrosis:** Fusion failure rates are higher in revision cases, particularly when smoking, osteoporosis, diabetes, or infection contributed to the original failure.
- **Vertebral artery injury:** The vertebral arteries run through the transverse foramina on each side of the cervical vertebrae. Injury during screw placement or decompression can cause stroke or life-threatening hemorrhage. CT angiography may be obtained pre-operatively in complex revision cases.
- **C5 palsy:** Transient or permanent weakness of deltoid and biceps function from stretch or manipulation of the C5 nerve root during decompression — more common after posterior decompression of severe stenosis. Usually resolves over months.
- **Dysphagia (difficulty swallowing):** Prolonged retraction of the esophagus during anterior surgery and post-operative swelling can cause temporary or, rarely, permanent swallowing difficulty.
- **Hardware removal difficulty:** Osseointegrated screws, broken implants, and prior fusion bone may make hardware removal technically demanding. Specialized instruments are used.
- **Anesthetic risks:** Cervical deformity and instability require careful airway management — fiberoptic intubation may be needed to avoid cord injury during positioning.

Optimizing Your Outcome Before Revision Surgery — What You Can Do:

- Stop smoking completely — this is the single most important step you can take to maximize fusion rates and minimize infection risk
- Treat osteoporosis — pre-operative teriparatide (Forteo) therapy for 3–6 months significantly improves bone quality and screw fixation in high-risk patients
- Control blood sugar — target HbA1c below 7.5% before any elective revision procedure
- Optimize your weight — obesity substantially increases all complication rates and reduces fusion rates
- Complete all cardiac, pulmonary, and medical clearances as directed by your team
- Discuss external bone stimulator use with Dr. Caridi — a pulsed electromagnetic field device worn post-operatively improves fusion rates in high-risk revision cases

7. Recovery After Cervical Revision Surgery

Recovery from cervical revision surgery varies significantly depending on the type and extent of the procedure. The following timeline applies to most revision cases; complex deformity corrections require longer stays and more extended rehabilitation:

Hospital Stay 2–5 days	Mobilization begins day 1. A rigid cervical collar is fitted before discharge and worn as instructed. Swallowing function monitored after anterior approaches. Neuro checks performed regularly. Complex deformity cases may require ICU observation overnight.
Weeks 1–4 Home Recovery	Wear cervical collar as instructed. Light activity; no heavy lifting, no driving while on narcotics or in a collar. Wound check at 10–14 days. Swallowing and voice often improve gradually. Begin bone stimulator use as directed.
Weeks 4–8 Rehabilitation	Collar may be weaned based on imaging and Dr. Caridi's assessment. Outpatient physical therapy for cervical range of motion, strengthening, and posture. X-rays at 6 weeks evaluate hardware position and early fusion. Return to desk work typically at 4–6 weeks.
Months 3–6 Fusion Assessment	CT scan at 3–6 months to assess fusion progress and hardware stability. Most patients experience significant improvement in pain and function by this point. Activity expanded as cleared by Dr. Caridi. Continue bone stimulator until fusion confirmed.
Months 6–18 Full Recovery	Fusion matures over 12–18 months. Final imaging at 12 months confirms solid union. The large majority of well-selected and pre-operatively optimized revision patients achieve meaningful, lasting improvement in pain and neurological function.

8. When to Seek Evaluation

Do not assume that new or worsening symptoms after prior cervical surgery are simply a permanent consequence of your condition. Many patients live with correctable problems for years unnecessarily. Please contact Spinal Associates if you experience any of the following:

Seek Evaluation With Dr. Caridi If You Experience:

- Return of neck pain or arm pain after a period of improvement following prior surgery
- New or different pattern of arm pain, numbness, or tingling not present before
- Progressive forward-stooped posture or inability to hold your head upright
- Difficulty swallowing or changes in your voice after prior cervical surgery
- New or worsening hand clumsiness, grip weakness, or balance problems — these may indicate cord compression requiring urgent evaluation
- Neck pain that is clearly worse with movement and better with rest
- Prior cervical disc replacement with new neck or arm symptoms
- You were told at your last visit that your fusion may not have fully healed
- Any sudden new neurological deficit — seek emergency evaluation immediately

Cervical revision surgery demands the highest level of surgical planning, technical precision, and experience. Dr. Caridi's training in complex cervical and deformity surgery encompasses the full spectrum of revision procedures — from single-level anterior revision ACDF to multi-level posterior deformity correction. He will work with you to determine whether revision surgery is the right option and to build a plan that gives you the best possible chance of lasting improvement.