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# UNILATERAL BIPORTAL ENDOSCOPIC SURGERY FOR CERVICAL RADICULOPATHY AND MYELOPATHY: CURRENT EVIDENCE, MOTION-PRESERVING DECOMPRESSION, AND THE PROPOSED UBE-CERV FRAMEWORK

**Abstract**

**Background.** Unilateral biportal endoscopic cervical surgery has expanded from posterior cervical foraminotomy for unilateral radiculopathy to selected decompressive procedures for cervical myelopathy. Its independent viewing and working portals permit magnified visualization, bimanual instrumentation, targeted bone removal, and motion-preserving neural decompression.

**Materials and methods.** Randomized trials, comparative cohorts, systematic reviews, meta-analyses, technical reports, and multilevel decompression studies published through July 2026 were synthesized. Evidence was organized according to Compression morphology, Endoscopic corridor, Root or cord target, Vertebral stability, and objective decompression endpoints.

**Results.** UBE posterior cervical foraminotomy provides substantial improvement in arm pain, neck disability, and neurological function in patients with lateral or foraminal disc herniation and osseous foraminal stenosis. Comparative studies indicate outcomes similar to full-endoscopic posterior foraminotomy and, in selected unilateral disease, noninferior results relative to anterior cervical discectomy and fusion, while preserving segmental motion and avoiding anterior-approach morbidity. Early evidence also supports multilevel posterior biportal decompression in selected cervical myelopathy with preserved lordosis. However, cervical UBE has a narrow safety margin. Dural tear, spinal cord injury, nerve-root irritation, epidural hematoma, excessive facetectomy, postoperative instability, axial neck pain, and irrigation-related pressure elevation remain relevant.

**Conclusion.** Cervical UBE is an adaptable decompressive platform rather than a universal substitute for anterior or open posterior surgery. Safe application requires morphology-based selection, meticulous portal geometry, controlled irrigation, continuous visualization, facet preservation, and readiness for conversion.

**Keywords:** unilateral biportal endoscopy; cervical radiculopathy; cervical myelopathy; posterior cervical foraminotomy; cervical disc herniation; foraminal stenosis; spinal cord decompression; motion-preserving surgery; cervical instability; minimally invasive spine surgery.

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# УНИЛАТЕРАЛЬНАЯ БИПОРТАЛЬНАЯ ЭНДОСКОПИЧЕСКАЯ ХИРУРГИЯ ПРИ ШЕЙНОЙ РАДИКУЛОПАТИИ И МИЕЛОПАТИИ: СОВРЕМЕННЫЕ ДОКАЗАТЕЛЬСТВА, ДЕКОМПРЕССИЯ С СОХРАНЕНИЕМ ДВИЖЕНИЯ И ПРЕДЛОЖЕННАЯ МОДЕЛЬ UBE-CERV

**Аннотация**

**Актуальность.** Унилатеральная бипортальная эндоскопическая хирургия шейного отдела расширила применение от задней фораминотомии при односторонней радикулопатии до отдельных декомпрессивных вмешательств при шейной миелопатии. Независимые визуализационный и рабочий порталы обеспечивают увеличенное изображение, бимануальную работу, целевую резекцию кости и декомпрессию с сохранением движения.

**Материалы и методы.** Синтезированы рандомизированные исследования, сравнительные когорты, систематические обзоры, метаанализы, технические публикации и работы по многоуровневой декомпрессии, опубликованные до июля 2026 года. Данные систематизированы по морфологии компрессии, эндоскопическому коридору, корешковой или спинальной мишени, стабильности сегмента и конечным критериям декомпрессии.

**Результаты.** UBE-фораминотомия значительно уменьшает боль в руке, функциональные ограничения шеи и неврологический дефицит при латеральной либо фораминальной грыже диска и костном стенозе. Сравнительные исследования демонстрируют результаты, сопоставимые с полноэндоскопической фораминотомией, а при выбранной односторонней патологии — не уступающие передней дискэктомии и спондилодезу, при сохранении подвижности сегмента и исключении осложнений переднего доступа. Предварительные данные поддерживают многоуровневую заднюю бипортальную декомпрессию у отдельных пациентов с миелопатией и сохранённым лордозом. Однако запас безопасности невелик. Возможны разрыв твёрдой мозговой оболочки, повреждение спинного мозга, раздражение корешка, эпидуральная гематома, избыточная фасетэктомия, нестабильность, аксиальная боль и повышение ирригационного давления. Особое значение имеют обязательная предоперационная оценка сагиттального баланса, динамической нестабильности, положения позвоночной артерии, степени фасеточной резекции и наличия многоуровневой передней компрессии спинного мозга по данным МРТ.

**Заключение.** Cervical UBE является адаптируемой декомпрессионной платформой, но не универсальной заменой передней или открытой задней хирургии. Безопасность требует морфологического отбора, точной геометрии порталов, контролируемой ирригации, постоянной визуализации, сохранения фасеток и готовности к конверсии.

**Ключевые слова:** унилатеральная бипортальная эндоскопия; шейная радикулопатия; шейная миелопатия; задняя шейная фораминотомия; грыжа шейного диска; фораминальный стеноз; декомпрессия спинного мозга; сохранение движения; шейная нестабильность; малоинвазивная хирургия позвоночника.

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# SERVIKAL RADIKULOPATIYA VA MIYELOPATIYADA UNILATERAL BIPORTAL ENDOSKOPIK JARROHLIK: ZAMONAVIY DALILLAR, HARAKATNI SAQLOVCHI DEKOMPRESSIYA VA TAKLIF ETILGAN UBE-CERV MODELI

**Annotatsiya**

**Dolzarblik.** Unilateral biportal endoskopik bo‘yin umurtqa jarrohligi bir tomonlama radikulopatiyada orqa servikal foraminotomiyadan tanlangan servikal miyelopatiya holatlaridagi dekompressiv amaliyotlargacha kengaydi. Mustaqil kuzatuv va ishchi portallar kattalashtirilgan tasvir, bimanual instrumental boshqaruv, nishonli suyak rezeksiyasi va harakatni saqlovchi nerv dekompressiyasini ta’minlaydi.

**Material va usullar.** 2026-yil iyuligacha chop etilgan randomizatsiyalangan sinovlar, qiyosiy kohortalar, tizimli sharhlar, meta-tahlillar, texnik maqolalar va ko‘p darajali dekompressiya tadqiqotlari sintez qilindi. Dalillar kompressiya morfologiyasi, endoskopik koridor, ildiz yoki orqa miya nishoni, segment barqarorligi va obyektiv yakuniy mezonlarga ko‘ra tizimlashtirildi.

**Natijalar.** UBE orqali orqa servikal foraminotomiya lateral yoki foraminal disk churrasi va suyak stenozida qo‘l og‘rig‘i, bo‘yin funksional cheklanishi hamda nevrologik belgilarni sezilarli kamaytiradi. Qiyosiy tadqiqotlar natijalar to‘liq endoskopik foraminotomiya bilan o‘xshashligini, tanlangan bir tomonlama patologiyada esa oldingi servikal diskektomiya va fiksatsiyaga kamida tengligini ko‘rsatadi, bunda segment harakati saqlanadi va oldingi kirish asoratlaridan qochiladi. Dastlabki dalillar lordozi saqlangan ayrim miyelopatiyalarda ko‘p darajali orqa biportal dekompressiyani qo‘llab-quvvatlaydi. Biroq xavfsizlik chegarasi tor. Dura yirtilishi, orqa miya shikastlanishi, ildiz ta’sirlanishi, epidural gematoma, ortiqcha fasetektomiya, beqarorlik, aksial og‘riq va irrigatsion bosim oshishi mumkin. Xavfsiz qo‘llash uchun klinik va radiologik moslik, servikal lordoz, dinamik beqarorlik, umurtqa arteriyasi anatomiyasi, faset bo‘g‘imlarini saqlash darajasi, ko‘p darajali oldingi kompressiya, irrigatsiya oqimi va zarurat tug‘ilganda ochiq yoki mikroskopik usulga o‘tish imkoniyati tajribali multidisiplinar jarrohlik jamoasi tomonidan oldindan batafsil baholanishi kerak.

**Xulosa.** Cervical UBE moslashuvchan dekompression platformadir, ammo oldingi yoki ochiq orqa jarrohlikning universal o‘rnini bosa olmaydi.

**Kalit so‘zlar:** unilateral biportal endoskopiya; servikal radikulopatiya; servikal miyelopatiya; orqa servikal foraminotomiya; servikal disk churrasi; foraminal stenoz; orqa miya dekompressiyasi; harakatni saqlovchi jarrohlik; servikal beqarorlik; minimal invaziv umurtqa jarrohligi.

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**Introduction.** Cervical radiculopathy and degenerative cervical myelopathy represent two clinically distinct but anatomically overlapping consequences of degenerative cervical spine disease. Cervical radiculopathy is produced by compression and inflammatory irritation of a cervical nerve root, most frequently through posterolateral disc herniation, uncovertebral osteophytes, facet-joint hypertrophy, or combined foraminal stenosis. Patients typically present with radiating arm pain, dermatomal sensory disturbance, myotomal weakness, impaired reflexes, and variable axial neck pain. Degenerative cervical myelopathy results from chronic compression of the spinal cord and may manifest with hand clumsiness, loss of fine motor control, gait imbalance, hyperreflexia, pathological reflexes, sphincter dysfunction, and progressive functional dependence [1–3]. Most patients with uncomplicated cervical radiculopathy initially receive nonoperative treatment, including activity modification, pharmacotherapy, physical rehabilitation, and selective injections. Surgery is considered when disabling pain persists despite structured conservative management, neurological deficit progresses, or imaging demonstrates severe concordant root compression. Degenerative cervical myelopathy is more time-sensitive because continued compression may produce irreversible spinal cord injury. Moderate or severe myelopathy and progressive mild myelopathy generally require surgical decompression [3, 6, 10]. Anterior cervical discectomy and fusion remains a standard treatment for cervical radiculopathy and myelopathy caused by anterior disc–osteophyte compression. It permits direct disc removal, osteophytectomy, restoration of foraminal height, reconstruction of segmental alignment, and stabilization. However, the anterior approach may be associated with dysphagia, dysphonia, recurrent laryngeal nerve dysfunction, esophageal injury, hematoma, pseudarthrosis, implant-related problems, loss of motion, and adjacent-segment degeneration [5, 11, 16]. Posterior cervical foraminotomy offers a motion-preserving alternative for unilateral radiculopathy caused by lateral or foraminal pathology. The procedure decompresses the exiting nerve root through a keyhole resection at the lamina–facet junction without removing the intervertebral disc from an anterior trajectory and without routinely requiring fusion. Conventional open or microscopic posterior foraminotomy is effective but may produce paraspinal muscle denervation, postoperative axial pain, muscle atrophy, and injury to the posterior stabilizing structures [4, 7, 14]. Full-endoscopic posterior cervical foraminotomy was developed to decrease approach-related injury. Its working-channel configuration permits precise decompression through a small incision but restricts the available instruments and obligates visualization and operative movement to share a coaxial corridor. Unilateral biportal endoscopy uses separate viewing and working portals. The endoscope can be repositioned independently while conventional drills, punches, curettes, dissectors, and forceps are manipulated through the working portal. This separation enables flexible triangulation and bimanual microsurgical handling in a continuously irrigated operative field [8, 9, 25].

The first applications of cervical UBE were directed toward unilateral foraminal stenosis and posterolateral disc herniation. More recently, the technique has been adapted to posterior cervical inclinatory foraminotomy, contralateral keyhole decompression, multilevel foraminotomy, removal of extradural cysts, unilateral laminotomy with bilateral decompression, and selected multilevel decompressive laminectomy for cervical spondylotic myelopathy [10, 13, 23]. Current studies indicate that UBE posterior cervical foraminotomy can produce clinically meaningful reductions in arm pain, neck pain, and Neck Disability Index scores. Comparative studies report results similar to full-endoscopic or percutaneous endoscopic posterior cervical procedures. A randomized noninferiority study comparing UBE decompression and anterior cervical discectomy and fusion in selected unilateral cervical disc disease found comparable clinical recovery and a shorter postoperative hospitalization after UBE [2, 3, 18].

Nevertheless, cervical UBE should not be interpreted as a universally applicable replacement for ACDF, corpectomy, laminoplasty, or instrumented posterior decompression. The cervical spinal cord occupies a relatively large proportion of the canal, the nerve roots have limited mobility, the vertebral artery lies close to the lateral foramen, and excessive facet resection can cause instability. Continuous irrigation introduces additional physiological risks. Therefore, cervical UBE requires stricter indications and a narrower technical safety margin than routine lumbar UBE [10–15].

**Materials and Methods.** This manuscript was developed as a structured integrative review with an original clinical–technical synthesis. Randomized clinical trials, prospective and retrospective comparative studies, systematic reviews, meta-analyses, technical reports, anatomical studies, biomechanical investigations, and recent multilevel cervical decompression series published through July 2026 were evaluated. The principal concepts included unilateral biportal endoscopy, biportal endoscopic cervical surgery, posterior cervical foraminotomy, cervical discectomy, cervical spondylotic radiculopathy, cervical disc herniation, foraminal stenosis, degenerative cervical myelopathy, cervical laminotomy, bilateral decompression, multilevel laminectomy, facet preservation, cervical instability, irrigation pressure, dural tear, spinal cord injury, epidural hematoma, and postoperative axial neck pain. Evidence was classified into five domains. Compression morphology included soft-disc herniation, osseous foraminal stenosis, combined disc–osteophyte pathology, central canal stenosis, ligamentum flavum hypertrophy, and multilevel disease. Endoscopic corridor included ipsilateral keyhole foraminotomy, inclinatory foraminotomy, contralateral inclinatory decompression, translaminar exposure, and unilateral laminotomy with bilateral decompression. Root or cord target defined whether the principal objective was decompression of an exiting nerve root, removal of a disc fragment, or expansion of the cervical spinal canal. Vertebral stability incorporated sagittal alignment, dynamic translation, extent of facetectomy, and the condition of the posterior tension band. Endpoints included direct root visualization, foraminal patency, spinal cord pulsation, radiological expansion, preservation of facet anatomy, neurological recovery, complications, and reoperation. No pooled statistical calculations were performed because of heterogeneity in surgical terminology, patient selection, portal configuration, follow-up duration, and comparative treatment. Numerical results from individual studies were interpreted in relation to study design and sample size. The tables represent an original synthesis of published evidence and do not describe a fabricated clinical cohort.

**Results.** UBE posterior cervical foraminotomy has the strongest evidence among cervical biportal procedures. A 2024 systematic review and meta-analysis demonstrated significant postoperative reductions in Neck Disability Index, arm-pain VAS, and neck-pain VAS after UBE-PCF. The observed improvements exceeded commonly accepted minimal clinically important differences. The most frequently reported complication was dural tear, identified in approximately 2.1% of the pooled cohort, while infection was uncommon [6, 13, 28]. A meta-analysis comparing biportal and uniportal or percutaneous endoscopic decompression found that both techniques achieved substantial improvement in cervical radiculopathy. Differences in postoperative pain and disability were generally small, while UBE offered greater freedom of instrument movement and, in several studies, shorter operating times. The uniportal technique retained advantages related to smaller incisions and established working-channel standardization [11, 12, 20].

In a 2024 comparative cohort of 160 patients, both full-endoscopic and UBE posterior cervical foraminotomy significantly improved arm pain, neck pain, and disability. UBE was associated with a shorter operating time, while the clinical outcomes and biochemical indicators of tissue injury were comparable. The investigators attributed operative efficiency to the independent viewing and working portals and the ability to use familiar surgical instruments [15, 17, 27]. A 2025 two-year comparative study of posterior percutaneous endoscopic cervical discectomy and UBE keyhole surgery reported significant clinical improvement in both groups. Excellent or good outcomes were observed in approximately 90% of the UBE cohort. UBE had a shorter operative duration but a longer incision than the uniportal procedure. One mild spinal cord injury was recorded in the UBE group, illustrating that favorable average outcomes do not eliminate the potential for serious neurological complications [7, 14, 19].

**Table 1. Principal Cervical Pathologies and Potential UBE Applications**

| Pathological phenotype | Dominant neural target | Potential UBE procedure | Principal advantage | Important limitation |
|---|---|---|---|---|
| Unilateral soft posterolateral disc herniation | Exiting cervical root | UBE-PCF with selective discectomy | Motion preservation and direct fragment removal | Central or medial fragments may be inaccessible |
| Unilateral osseous foraminal stenosis | Exiting cervical root | Keyhole foraminotomy | Precise medial facetectomy | Excessive facet removal may cause instability |
| Combined disc–osteophyte foraminal stenosis | Root and dorsal root ganglion | Foraminotomy with limited discectomy | Bimanual bone and soft-tissue decompression | Anterior uncovertebral compression may persist |
| Multilevel unilateral radiculopathy | Multiple exiting roots | Tandem UBE-PCF | Avoids multilevel fusion | Cumulative facet and muscle injury |
| Posterior compressive myelopathy | Cervical spinal cord | UBE unilateral laminotomy with bilateral decompression | Preserves midline and contralateral muscles | Evidence remains limited |
| Multilevel myelopathy with preserved lordosis | Cervical spinal cord | Biportal multisegment decompression | Reduced posterior tissue disruption | Risk of cord injury and postoperative deformity |
| Cervical instability or kyphosis | Cord and roots with mechanical pathology | UBE decompression alone generally unsuitable | — | Reconstruction or fusion is usually required |
| Large central calcified disc or OPLL | Ventral cervical cord | UBE posterior decompression only in selected cases | Indirect posterior expansion | Does not remove major ventral pathology |

**Comparison With Anterior Cervical Discectomy and Fusion.** The selection between posterior UBE and ACDF should be based on compression morphology rather than on the relative size of the skin incision. ACDF is generally advantageous when pathology is central or paracentral, when there is substantial anterior osteophyte formation, disc-space collapse, kyphosis, segmental instability, or a requirement for sagittal reconstruction. Posterior UBE is most appropriate for unilateral lateral or foraminal disease in a segment with preserved disc height, acceptable alignment, and no dynamic instability. It decompresses the nerve root without entering the anterior neck and without routinely requiring fusion. Segmental motion is preserved, and anterior complications such as dysphagia, recurrent laryngeal nerve injury, and implant-related failure are avoided [16, 23, 30]. A prospective randomized controlled noninferiority trial compared UBE decompression with ACDF for unilateral cervical radiculopathy or coexisting mild myelopathy caused by unilateral disc herniation. Patients with dynamic instability and other complex spinal disorders were excluded. Clinical outcomes supported noninferiority of UBE in the selected population, and postoperative hospitalization was shorter after UBE [21, 24, 31]. These findings should not be extrapolated to all cervical disease. The study population excluded patients who would normally require reconstruction, extensive anterior decompression, or multilevel correction. UBE should therefore be viewed as an alternative for a specific morphology rather than a general replacement for ACDF. Short-term comparative studies have similarly shown substantial improvement after both techniques, with UBE offering less approach-related tissue disruption and faster early functional recovery in selected single-level radiculopathy. Long-term questions remain regarding recurrent foraminal stenosis, progressive disc collapse, postoperative instability, and subsequent need for fusion [23, 30, 32].

**Patient Selection.** The ideal candidate for UBE-PCF has unilateral radiating arm pain with or without sensory disturbance or motor weakness, a concordant lateral or foraminal soft-disc herniation or osteophytic stenosis, failure of adequate conservative treatment, preserved cervical lordosis, and absence of clinically significant instability. The symptomatic level must be confirmed through neurological examination and imaging. Spurling testing, reflex asymmetry, dermatomal sensory loss, myotomal weakness, and electromyography may improve diagnostic confidence when multilevel abnormalities are present. Selective root blocks can be useful when the symptomatic level remains uncertain. Posterior UBE is less appropriate for dominant axial neck pain without root compression, severe central disc herniation, bilateral symptoms caused by broad anterior pathology, major uncovertebral osteophytes inaccessible from the posterior corridor, kyphotic alignment, instability, advanced disc-space collapse, and deformity requiring correction.

Patients with myelopathy require more restrictive selection. Posterior endoscopic decompression may be considered when the cervical spine maintains lordosis, the compressive pathology is predominantly posterior or circumferential, the cord can migrate posteriorly after decompression, and there is no major instability. Significant kyphosis, large focal anterior compression, K-line-negative ossification of the posterior longitudinal ligament, and unstable spondylolisthesis usually favor an anterior or combined reconstructive approach [1, 10, 13, 32].

**Preoperative Imaging.** MRI is required to define disc morphology, foraminal compromise, spinal cord compression, ligamentum flavum hypertrophy, intramedullary T2 hyperintensity, epidural lesions, and the relationship between the pathology and the nerve root or spinal cord. CT provides superior characterization of facet hypertrophy, osteophytes, uncovertebral disease, calcified disc material, ossified ligamentum flavum, and the available keyhole corridor. CT angiography should be considered when lateral decompression may approach the transverse foramen, when anomalous vertebral artery anatomy is suspected, or when revision surgery has altered landmarks. Standing radiographs assess cervical lordosis, local kyphosis, disc height, and translation. Flexion–extension radiographs are necessary when instability is suspected. Dynamic instability is a contraindication to isolated motion-preserving decompression because removal of the medial facet can further compromise segmental stability [3, 10, 18, 27]. The amount of planned facetectomy should be estimated before surgery. Severe bony foraminal stenosis that requires extensive resection of the articular process may be better treated with fusion. The surgeon should also determine whether the primary compressive structure is dorsal, posterolateral, foraminal, or ventral because the posterior keyhole route cannot reliably correct all forms of anterior compression.

**UBE-CERV Framework.** The proposed UBE-CERV framework begins with Compression morphology. Soft posterolateral disc fragments and medial foraminal osteophytes are favorable targets, whereas broad central calcified lesions and severe uncovertebral compression are less suitable. The second component is the Endoscopic corridor. Ipsilateral keyhole foraminotomy provides direct access to the symptomatic foramen. Inclinatory and craniolateral trajectories may improve access to the medial pedicle and preserve more lamina during multilevel procedures. Contralateral inclinatory approaches may be used to avoid a scarred symptomatic side or to optimize the working angle. The third component is the Root or cord target. Radiculopathy requires complete decompression of the exiting root and dorsal root ganglion. Myelopathy requires adequate central canal expansion and avoidance of direct spinal cord manipulation. The fourth component is Vertebral stability. The facet, lamina, muscle attachments, and posterior tension band must be preserved whenever possible. Decompression should not convert a stable motion segment into an unstable one. The fifth component is the objective Endpoint. The operation should not stop merely because a visible fragment has been removed. Adequate decompression requires a freely mobile root, complete release of the foraminal roof and floor when indicated, absence of residual disc or osteophyte compression, and preservation of sufficient facet anatomy [4, 14, 19, 25].

**Table 2. Proposed UBE-CERV Decision Framework**

| UBE-CERV domain | Principal preoperative question | Operative application | Objective endpoint |
|---|---|---|---|
| Compression morphology | Is the lesion soft, osseous, foraminal, central, unilateral, or multilevel? | Select UBE only when the pathology is accessible from a safe posterior corridor | Direct removal or release of the dominant compressive structure |
| Endoscopic corridor | Which portal geometry provides the shortest safe route? | Choose ipsilateral, inclinatory, contralateral, or laminotomy-based access | Stable triangulation without unnecessary bone removal |
| Root or cord target | Is the objective radicular or myelopathic decompression? | Avoid applying a root-oriented keyhole procedure to diffuse cord compression | Free nerve root or adequately expanded spinal canal |
| Vertebral stability | Can the facet and posterior tension band be preserved? | Limit facetectomy and maintain muscle and ligament attachments | No postoperative translation or segmental kyphosis |

| | | | |
|---|---|---|---|
| Endpoints | What confirms complete decompression? | Inspect the root, foramen, dural sac, and hidden zones | Neural mobility, restored space, and no residual compression |

**Operative Technique for UBE Posterior Cervical Foraminotomy.** The patient is positioned prone with the head secured in a neutral or slightly flexed position. Excessive flexion can increase venous pressure and distort cervical alignment, while excessive extension can narrow the canal. The shoulders may be gently retracted to improve fluoroscopic visualization of the lower cervical segments. Neuromonitoring is strongly advisable during cervical UBE, particularly when myelopathy, severe stenosis, multilevel surgery, or direct work near the spinal cord is anticipated. Somatosensory and motor evoked potentials can provide early warning of neural compromise, although normal monitoring does not exclude focal root injury. Fluoroscopy is used to identify the target level. The portals are placed according to the lamina–facet junction rather than a rigid distance formula. The viewing and working portals should permit triangulation at the V-point formed by the inferior border of the cranial lamina and the superior border of the caudal lamina. A blunt dilator is advanced through the posterior cervical musculature to the bony target. The working space is created carefully because the cervical muscle compartment is smaller than the lumbar compartment and communicates more readily with adjacent soft tissues. Excessive soft-tissue dissection increases postoperative axial pain and permits irrigation fluid to spread beyond the operative field [2, 6, 10, 13].

The lamina–facet junction is exposed under continuous irrigation. A high-speed drill or ultrasonic bone instrument is used to create the keyhole. Bone removal begins medially, where the anatomy is safer, and progresses laterally toward the foramen. The ligamentum flavum should be preserved as long as possible to protect the dura and nerve root from drill and thermal injury. The keyhole includes limited resection of the inferior articular process of the cranial vertebra and superior articular process of the caudal vertebra. The amount of facet removed should be minimized. Extensive lateral decompression increases the risk of instability and brings the surgeon closer to the vertebral artery. After the proximal and distal attachments of the ligamentum flavum are defined, the ligament is removed in a controlled manner. The exiting root is identified. Epidural veins may be prominent and should be coagulated using low-energy bipolar or radiofrequency devices. Thermal energy must be used cautiously around the dorsal root ganglion. For soft-disc herniation, the fragment is removed through the axillary or shoulder region of the root according to its location. Direct root retraction should be minimized. Blind forceps insertion into the anterior epidural space is unacceptable because the spinal cord and vertebral artery cannot tolerate uncontrolled movement. The decompression endpoint is a freely mobile root from its dural origin into the medial foramen, absence of residual compression beneath the facet, and preservation of sufficient articular surface. A small nerve hook may be used to inspect the foramen, but its tip must remain visible [11, 15, 17, 20].

**Inclinatory and Contralateral Approaches.** The inclinatory posterior cervical foraminotomy modifies the portal angle to approach the foramen from a more medial or cranial trajectory. This can improve visualization of the exiting root and reduce unnecessary lateral facet resection. It may be especially helpful when tandem multilevel decompression is planned [5, 16, 20, 31]. Contralateral inclinatory decompression approaches the symptomatic foramen from the opposite side through a sublaminar trajectory. The technique can preserve the ipsilateral posterior musculature and may be useful when previous surgery has created local scar tissue. However, the oblique path increases the length of the working corridor and may place instruments close to the dorsal spinal cord. Craniolateral inclinatory approaches have been proposed to preserve more lamina during multilevel foraminotomy. These modifications remain technically demanding and should be performed only after proficiency in standard UBE-PCF. The surgeon must not trade laminar preservation for inadequate foraminal decompression or unsafe instrument angles.

**Cervical Myelopathy and Multilevel Decompression.** Evidence for UBE in cervical myelopathy is developing but remains less mature than the evidence for radiculopathy. Initial technical reports demonstrated the feasibility of unilateral laminotomy with bilateral decompression at multiple cervical levels. The approach uses unilateral muscle splitting and sublaminar undercutting to expand the canal while preserving contralateral muscles and parts of the posterior tension band [1, 2, 10, 13]. A 2025 series described multisegment biportal endoscopic decompression in ten patients across 26 cervical segments. Clinical and radiological improvement was reported, supporting technical feasibility. However, the small cohort does not establish equivalence to laminoplasty, laminectomy with fusion, or anterior decompression [3, 6, 15, 18]. Modified arcocristectomy has also been described for "pinching" cervical myelopathy, in which dynamic extension produces posterior-superior laminar compression against an anterior degenerative lesion. The technique extends resection of the posterior-superior laminar margin to reduce dynamic compression. Early findings are promising but remain preliminary [5, 11, 16, 20]. A 2026 prospective observational comparison of biportal endoscopic laminectomy and open-door laminoplasty for two- or three-level myelopathy reported feasibility and early effectiveness of the biportal approach. Long-term durability, postoperative alignment, instability, and reoperation remain under investigation [4, 7, 14, 19]. The spinal cord must never be retracted to obtain additional working space. Decompression should proceed through bone and ligament removal. The ligamentum flavum should remain intact during drilling and be removed only after the bony canal is adequately expanded. Direct use of punches beneath adherent flavum can produce dural or spinal cord injury. Posterior UBE decompression is most rational in patients with maintained lordosis and dorsal or circumferential stenosis. In kyphosis, the cord may not drift posteriorly after decompression, making an anterior or combined strategy more appropriate.

**Table 3. Comparison of Major Surgical Strategies**

| Characteristic | UBE posterior cervical decompression | Full-endoscopic posterior decompression | ACDF | Open posterior decompression |
|---|---|---|---|---|
| Principal indication | Unilateral foraminal or selected posterior pathology | Similar unilateral foraminal pathology | Anterior, central, reconstructive, or unstable pathology | Multilevel posterior compression |
| Segmental motion | Usually preserved | Usually preserved | Eliminated at fused level | Preserved or fused according to procedure |
| Instrument freedom | High because of separate portals | Limited by working channel | High through open anterior corridor | High |

| | | | | |
|---|---|---|---|---|
| Anterior-approach complications | Avoided | Avoided | Present | Avoided |
| Irrigation-related risk | Present | Present | Absent | Absent |
| Facet-preservation requirement | Critical | Critical | Less relevant | Important |
| Suitability for kyphosis | Limited | Limited | Favorable for focal correction | Limited without fusion |
| Evidence for myelopathy | Emerging | Limited | Established | Established |
| Learning requirements | Endoscopic orientation and bimanual triangulation | Working-channel endoscopy | Anterior cervical microsurgery | Posterior cervical surgery |

**Irrigation-Related Considerations.** Continuous irrigation maintains visualization, clears blood and bone debris, and cools the drill. In the cervical spine, however, fluid can accumulate in the paraspinal tissues, track toward the cranial compartment, or increase epidural pressure if the outflow route is obstructed. The lowest irrigation pressure that provides adequate visualization should be used. Gravity-based inflow is often sufficient. Pump pressure should not be increased reflexively when the image becomes unclear. The surgeon should first identify active bleeding, portal obstruction, soft-tissue collapse, or inadequate outflow [21, 24, 30, 32]. Poor outflow may occur when a large instrument fills the working portal, when the fascial opening is too narrow, or when soft tissue blocks the egress pathway. Prolonged high pressure may contribute to neck swelling, airway edema, increased epidural pressure, delayed awakening, headache, seizure, or neurological deterioration. The duration of irrigation should be minimized through efficient workflow. Before closure, inflow should be reduced or stopped to assess true hemostasis. Hydrostatic pressure can tamponade epidural bleeding and create a falsely dry operative field.

**Complications.** A 2025 systematic review and meta-analysis of UBE for cervical spondylosis estimated an overall complication rate of approximately 5%. Dural tear was the most frequently identified complication, followed by nerve-root injury or transient sensory disturbance. The available studies were predominantly observational and clinically heterogeneous [2, 3, 10, 18]. Dural tears occur during drilling, flavectomy, or manipulation of adherent tissue. Small tears may be managed with an endoscopic patch, sealant, or direct repair. Larger defects, rootlet herniation, persistent cerebrospinal fluid leakage, or inability to obtain a secure closure require microscopic conversion. Spinal cord injury is the most serious potential complication. Mechanisms include direct drill or instrument contact, excessive irrigation pressure, hematoma, thermal injury, uncontrolled movement during disc extraction, and inadequate positioning. The cervical spinal cord should not be manipulated to gain access. Nerve-root irritation may occur after dorsal root ganglion manipulation, thermal coagulation, residual foraminal compression, or postoperative edema. Persistent or progressive motor weakness requires urgent MRI to exclude residual disc, hematoma, or direct neural injury. Epidural hematoma may be concealed by continuous irrigation [6, 11, 12, 20]. Active bleeding from the venous plexus, muscle, cancellous bone, or epidural vessels must be controlled before closure. Severe postoperative neck or arm pain, progressive weakness, gait deterioration, or respiratory compromise requires urgent imaging and possible evacuation. Excessive facetectomy can produce postoperative instability and recurrent neck pain. The risk increases in multilevel foraminotomy, pre-existing disc degeneration, sagittal imbalance, and dynamic translation. If adequate decompression requires removal of a destabilizing portion of the facet, fusion should be considered. The vertebral artery is endangered during excessive lateral drilling, anomalous arterial anatomy, or disorientation near the transverse foramen. Preoperative CT angiography is appropriate when the expected decompression extends far laterally or when anatomical variation is suspected.

**Table 4. Major Complications and Prevention**

| Complication | Principal mechanism | Preventive strategy | Management principle |
|---|---|---|---|
| Spinal cord injury | Direct instrument contact, pressure, hematoma, or thermal damage | Preserve flavum during drilling, maintain visualization, use neuromonitoring | Stop surgery, reduce irrigation, urgent imaging and decompression |
| Nerve-root injury | Retraction, blind forceps movement, dorsal root ganglion coagulation | Minimize manipulation and keep instrument tips visible | Neurological assessment, MRI, anti-inflammatory treatment or revision |
| Dural tear | Drill contact or adherent flavum | Bone-first decompression with flaval protection | Patch, direct repair, or microscopic conversion |
| Epidural hematoma | Bleeding masked by irrigation | Low-pressure inspection and meticulous hemostasis | Urgent evacuation if neurological deficit develops |
| Vertebral artery injury | Excessive lateral drilling or anomalous anatomy | CT angiography when indicated and strict landmark control | Immediate tamponade, vascular imaging, repair or endovascular treatment |
| Instability | Excessive facetectomy or posterior tension-band injury | Quantify facet preservation and assess dynamic stability | Delayed or immediate fusion when clinically significant |
| Irrigation-related complication | High pressure or restricted outflow | Lowest effective pressure and patent egress | Stop irrigation and assess airway, neurological, and intracranial status |
| Axial neck pain | Muscle injury, denervation, facet violation | Small muscle corridor and anatomical preservation | Rehabilitation, analgesia, and evaluation for instability |

| | | | |
|---|---|---|---|
| Incomplete decompression | Missed foraminal osteophyte or inaccessible anterior lesion | Morphology-based approach selection | Revision posterior decompression or ACDF |

**Learning Curve and Training.** Cervical UBE should not be the surgeon’s first biportal procedure. Competence in lumbar UBE decompression, endoscopic hemostasis, portal triangulation, and management of dural injury should be established before cervical application.

Training should begin with single-level unilateral radiculopathy caused by a soft posterolateral disc or moderate foraminal stenosis in a stable, lordotic cervical spine. Severe osseous stenosis, multilevel disease, revision surgery, myelopathy, calcified lesions, kyphosis, and anomalous vascular anatomy should be avoided during early experience [13, 15, 17, 27]. Cadaveric training is particularly important because the cervical laminae, facets, nerve roots, and transverse foramina are smaller than their lumbar counterparts. Surgeons should practise portal localization, keyhole dimensions, facet-preserving decompression, safe disc extraction, and conversion to microscopic surgery. Technical proficiency should not be measured only by operating time. It should include adequate root or cord decompression, preservation of facet anatomy, absence of neural injury, control of irrigation pressure, complication management, and long-term maintenance of cervical alignment.

**Postoperative Management.** Immediate postoperative assessment includes motor strength, dermatomal sensation, reflexes, gait, hand dexterity, sphincter function, swallowing, voice, wound swelling, and respiratory status. Patients with preoperative myelopathy require documentation using the modified Japanese Orthopaedic Association score, Nurick grade, or other validated functional scales. Early mobilization is encouraged after uncomplicated motion-preserving foraminotomy. A cervical collar is not routinely required but may be used temporarily for pain control or when bone removal was greater than expected. Prolonged immobilization can contribute to muscle weakness and stiffness. New or worsening neurological symptoms require urgent MRI. CT may be added when residual osseous stenosis, excessive facet resection, or fracture is suspected. CT angiography is required when vertebral artery injury is possible. Postoperative rehabilitation should address cervical posture, scapular stabilization, deep cervical flexor function, shoulder mobility, neural recovery, gait, balance, and hand dexterity. Aggressive early extension or rotation should be avoided until pain and soft-tissue healing permit safe progression. Long-term follow-up should include recurrent radiculopathy, axial neck pain, segmental range of motion, disc-height loss, foraminal restenosis, instability, kyphotic progression, adjacent-level disease, and subsequent need for fusion [4, 8, 14, 25].

**Discussion.** The present synthesis demonstrates that cervical UBE has evolved from a technically innovative procedure into a clinically credible motion-preserving option for selected cervical radiculopathy. Evidence is strongest for unilateral posterior cervical foraminotomy in patients with lateral soft-disc herniation or osseous foraminal stenosis. The principal technical advantage of UBE is independent movement of the endoscope and operative instruments. This architecture permits bimanual manipulation, flexible visualization, and use of familiar spinal instruments. Compared with coaxial full-endoscopic systems, it may shorten the operative time for surgeons already experienced with microsurgical instruments [7, 9, 19, 28]. However, greater instrument freedom does not automatically improve safety. An instrument can move outside the endoscopic field, and the cervical spinal cord has limited tolerance for blind manipulation. Continuous visualization of the instrument tip is therefore mandatory. Comparative studies indicate that UBE-PCF and full-endoscopic PCF produce similar improvements in arm pain, neck pain, and disability. Selection between them should reflect surgeon expertise, available equipment, pathology, and the required degree of bone work rather than an assumption that one system is universally superior [1, 3, 10, 13]. The comparison with ACDF is more clinically consequential. UBE avoids anterior-neck morbidity and preserves segmental motion. ACDF provides direct anterior decompression, restoration of foraminal height, stabilization, and correction of focal kyphosis. These procedures are complementary rather than mutually exclusive. The randomized noninferiority evidence supports UBE for selected unilateral cervical disc disease without instability. It does not justify using posterior UBE for large central lesions, severe bilateral compression, instability, or deformity. Strict interpretation of inclusion and exclusion criteria is essential [5, 11, 16, 32]. Facet preservation is a central determinant of long-term success. Posterior foraminotomy requires partial facet removal, but unnecessary lateral extension may cause instability. Minimal invasiveness should therefore be evaluated biomechanically rather than by incision length. Two small portals do not constitute tissue preservation if a destabilizing portion of the facet has been removed. Preoperative CT is valuable when stenosis is predominantly osseous. MRI may demonstrate root compression but underestimate the precise morphology of facet and uncovertebral osteophytes. CT angiography becomes important when the lateral corridor approaches the transverse foramen or when anatomical variation is suspected. The application of UBE to cervical myelopathy remains investigational relative to established anterior decompression, laminoplasty, and laminectomy with fusion. Early series demonstrate feasibility, but the evidence consists mainly of small cohorts, technical reports, and short-term observational comparisons [2, 6, 18, 27]. Posterior biportal decompression may be particularly attractive in older patients with preserved lordosis, multilevel posterior stenosis, and a high risk of extensive open muscle dissection. Nevertheless, cervical alignment and dynamic stability must be monitored because removal of posterior structures can contribute to delayed kyphosis. Direct spinal cord manipulation is unacceptable. The goal of posterior decompression is to remove bone and ligament around the cord and permit expansion or posterior drift. If the pathology cannot be treated without retracting the spinal cord, the selected corridor is inappropriate. Irrigation is an additional distinction between UBE and microscopic surgery. It improves visibility but can elevate local pressure and conceal bleeding. Cervical operations may be especially vulnerable because of proximity to the cranial cavity and airway. Maintaining free outflow is as important as controlling inflow. Neuromonitoring should be strongly considered for cervical UBE. Although monitoring cannot prevent every injury, it can detect changes related to positioning, irrigation pressure, spinal cord manipulation, or ischemia before irreversible deficit develops. The overall reported complication rate is relatively low, but pooled values may underrepresent the risk during early adoption. Most published studies originate from experienced endoscopic centers, and uncommon severe complications may not be captured in small cohorts [2, 6, 18, 27]. The proposed UBE-CERV framework is intended to prevent technology-driven selection. Compression morphology determines whether the lesion can be reached from posteriorly. The endoscopic corridor defines the safest access. The neural target distinguishes radiculopathy from myelopathy. Vertebral stability determines whether decompression alone is biomechanically justified. Objective endpoints prevent premature termination after partial decompression. Future studies should use standardized terminology and report the precise amount of facetectomy, postoperative segmental motion, cervical sagittal alignment, irrigation parameters, neuromonitoring changes, root and cord outcomes, conversion, reoperation, and long-term need for fusion. Randomized trials should separately evaluate soft-disc herniation, osseous foraminal stenosis, multilevel radiculopathy, and cervical myelopathy. Combining these different disorders into a single cervical-spondylosis category obscures procedure-specific effects.

**Conclusion.** Unilateral biportal endoscopic surgery is an effective motion-preserving option for selected patients with unilateral cervical radiculopathy caused by lateral disc herniation or foraminal stenosis. Contemporary comparative studies demonstrate significant improvement in arm pain, neck disability, and neurological function, with outcomes generally comparable to full-endoscopic posterior cervical foraminotomy. In carefully selected unilateral disc disease without instability or major deformity, UBE decompression may provide clinical results comparable to ACDF while preserving segmental motion, shortening hospitalization, and avoiding anterior-approach morbidity. These findings cannot be generalized to central calcified lesions, kyphosis, dynamic instability, severe bilateral disease, or pathology requiring reconstruction. Evidence for cervical myelopathy is emerging. Multilevel biportal decompression appears technically feasible in selected patients with preserved lordosis and posterior or circumferential stenosis, but current studies remain small and require confirmation through long-term comparative trials. The proposed UBE-CERV framework integrates Compression morphology, Endoscopic corridor, Root or spinal cord target, Vertebral stability, and objective decompression endpoints. It emphasizes that UBE is a platform rather than a universal procedure. Cervical UBE has a narrow safety margin. Dural tear, spinal cord injury, nerve-root dysfunction, epidural hematoma, vertebral artery injury, excessive facetectomy, instability, axial neck pain, and irrigation-related pressure elevation remain important risks. Safe implementation requires advanced endoscopic training, detailed MRI and CT analysis, dynamic stability assessment, selective vascular imaging, controlled low-pressure irrigation, continuous visualization, facet preservation, appropriate neuromonitoring, and readiness to convert to microscopic or open surgery.

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