10 Cervical Laminectomy and Laminoplasty as Treatment of Spinal Stenosis

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10.1 Introduction

A variety of surgical options are available for the treatment of cervical spondylotic myelopathy (CSM) and radiculopathy due to cervical spondylosis. Ultimately, the goal of any surgical method is to alleviate pain, decompress the spinal cord and nerve roots, maintain the alignment of the cervical spine as much as possible, and stabilize if necessary.

Anterior approaches to the cervical spine, as described in Chap. 8, are generally preferred in patients who have cervical myelopathy due to mainly anterior compression of their spinal cord, or have a loss of cervical lordosis, or, besides their myelopathic complaints, also have important neck pain.

When the anterior approach is contraindicated, such as in ossification of the posterior longitudinal ligament (OPLL) with dural penetration and when the spinal cord lesion is rather diffuse or more dorsal due to buckling of the ligamentum flavum, or when more than three levels are affected, posterior procedures can be offered. Patients with preserved cervical lordosis are appropriate candidates for a posterior approach. Posterior decompression however can result in inadequate decompression or increased postoperative deformity in patients with cervical kyphosis associated with impaired function and persistent pain.

Cervical laminectomy offers posterior access to the cervical spinal canal and entails removal of

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the spinous process, lamina, and occasionally parts of the facet joints (when combined with foraminotomy) [1, 2]. Laminectomy is commonly used to treat conditions, such as cervical (radiculo-)myelopathy secondary to spondylosis (CSM), ossification of the posterior longitudinal ligament (OPLL), or primary (congenital) stenosis, and has been demonstrated to carry a lower risk of surgical complications (e.g., neurological deterioration, dysphagia, construct failure, pseudarthrosis) as compared to polysegmental anterior decompressive procedures, especially in the elderly and in patients with reduced bone quality due to osteoporosis/osteopenia [1, 3–7]. In contrast to multisegmental anterior decompressive techniques, (instrumented) arthrodesis is not mandatory when performing laminectomy (laminoplasty) in patients older than 50 years, with stable, lordotic cervical spines, allowing for long-term preservation of cervical motion [1, 8, 9]. Conversely, laminectomy without arthrodesis entails a considerable incidence of kyphosis in young patients [10–14] and patients with cervical hypermobility [15] (Figs. 10.1 and 10.2).

When indicated, cervical laminectomy may be combined with instrumented arthrodesis (See Chap. 12) [1, 6–8]. In contrast to anterior surgical techniques, the posterior approach to the cervical spine allows for comprehensive decompression and (instrumented) arthrodesis ranging

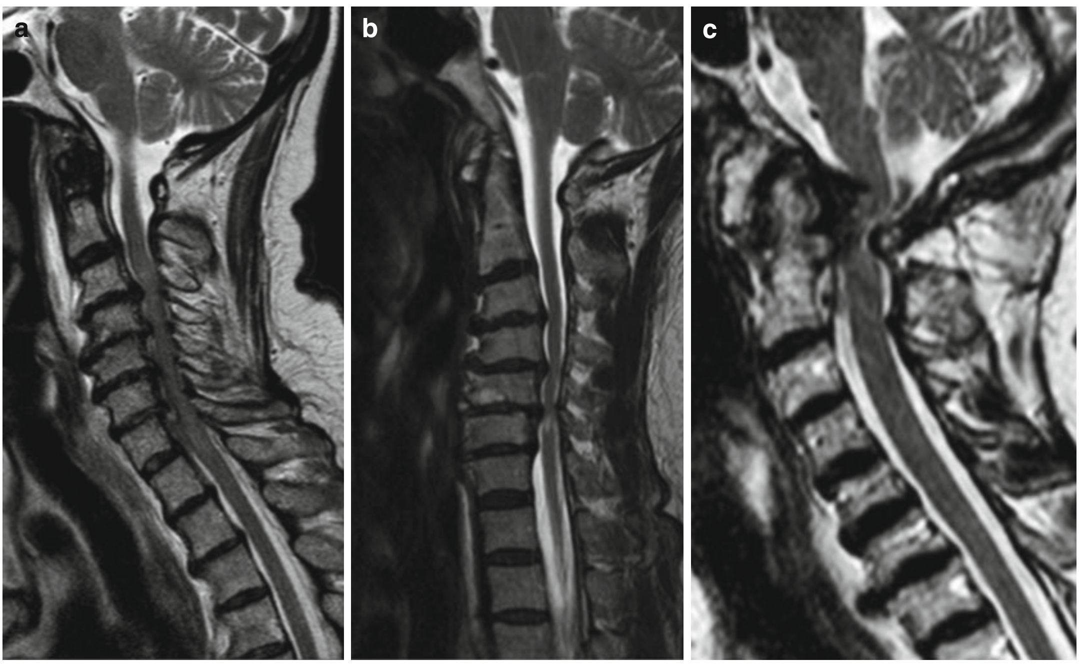

Fig. 10.1 (**a**) MRI imaging of cervical spondylotic myelopathy due to multisegmental degenerative cervical stenosis in a 64-year-old female patient spanning the subaxial spine from C3/C4 down to C6/C7. The cervical lordosis is lost, yet without manifest kyphosis, representing a good indication for posterior cervical decompression (laminectomy or laminoplasty). However, anterior decompression and fusion is a viable surgical alternative. (**b**) Corresponding MRI imaging of *congenital* stenosis with additional degenerative changes in a 58-year-old male causing early signs of cervical myelopathy. Anterior decompression is not advocated in these cases. As there is already a minor degree of cervical kyphosis (with residual flexibility in F/E radiographs), the preferred mode of treatment is laminectomy and posterior instrumented fusion. (**c**) Sagittal MRI showing severe stenosis at the craniocervical junction due to chronic axial and vertical C0/C1/C2 instability with massive retrodental callus formation and resultant medullary compression. Posterior decompression and fusion alone will likely not result in symptom resolution in this 76-year-old female due to the massive anterior cord compression and displacement. Therefore, the anterior mass was resected via a dorsal approach following posterior fossa decompression and C1 laminectomy (see Fig. 10.2)

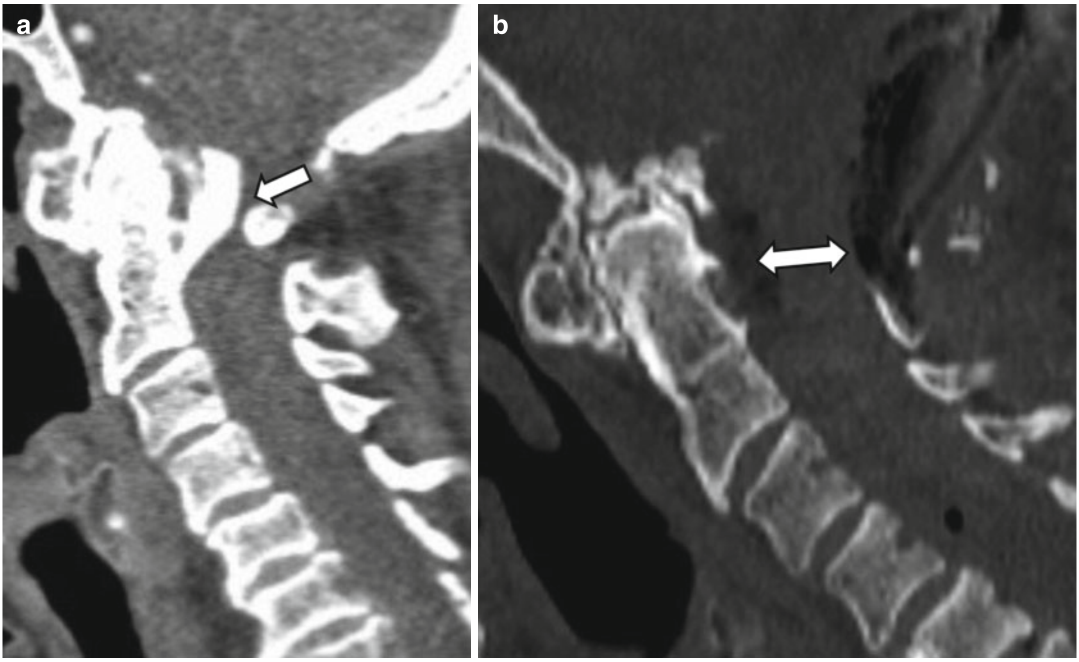

Fig. 10.2 (**a**) Preoperative sagittal CT reconstruction in a patient with severe craniocervical stenosis (see Fig. 10.1). A filiform residual canal lumen is indicated by *white arrow*. (**b**) Corresponding postoperative CT following combined anterior and posterior decompression and instrumented craniocervical arthrodesis performed via a posterior craniocervical approach, demonstrating recalibration of the rostral spinal canal

from the craniocervical down to the cervicothoracic junction. Posterior cervical instrumentation ranges from (mostly historic) wiring and plating techniques to comprehensive screw-rod fixation [16–19], enabling the surgeon to restore stability as well as to correct the sagittal profile in flexible cervical spines. It is good to remember that the ideal sagittal profile of the patient is not always a lordosis. Only in 50 % of asymptomatic patients, a "typical" cervical lordosis is recorded.

10.2 Surgical Indications

10.2.1 Cervical Laminectomy

With the exception of significant anterior cord compression in a stiff, kyphotic cervical spine, or associated with important neck pain, laminectomy (combined with posterior foraminotomy) may offer an effective treatment for CSM, OPLL, and primary (congenital) stenosis of the cervical spinal canal [20, 21]. Laminectomy should be avoided in cases of ankylosing spondylitis or diffuse idiopathic skeletal hyperostosis (DISH). Radiographic features of DISH include linear new bone formation along the anterolateral aspect of the cervicothoracic spine, a bumpy contour, subjacent radiolucency, and irregular and pointed bony excrescences at the superior and inferior vertebral margins in the cervical and lumbar regions. Pathologic features include focal and diffuse calcification and ossification in the anterior longitudinal ligament, paraspinal connective tissue and annulus fibrosis, degeneration in the peripheral annulus fibrosis fibers and Y-shaped anterolateral extensions of fibrous tissue, hypervascularity, chronic inflammatory cellular infiltration, and periosteal new bone formation on the anterior surface of the vertebral bodies. The incidence of DISH seems to increase in the Western aging population (Fig. 10.3). In these patients, the anterior column offers no support. As such, resection of their posterior elements may trigger troublesome sequelae.

Fig. 10.3 Sagittal reformatted CT image of cervical spine in 73-year-old woman with diffuse idiopathic skeletal hyperostosis (DISH) shows radiolucent disk extension (*arrow*) that isolates small triangular ossicle in front of the disk space

10.2.2 Cervical Laminoplasty

Cervical laminoplasty is indicated for cases of cervical myelopathy or myeloradiculopathy due to degenerative cervical spondylosis, OPLL, multilevel disk herniations, intraspinal tumors, hematoma, or acute traumatic central cord syndrome, extending more than three intervertebral disk spaces (see Chap. 11). Patients undergoing laminoplasty should have lordotic cervical spine alignment and no instability on dynamic radiographs. Stenosis at less than three disk levels is not an indication for laminoplasty, because the limited length of decompression achieved in these cases does not allow the spinal cord to effectively migrate dorsally. Similarly, kyphotic deformity of the cervical spine is a contraindication for laminoplasty/laminectomy, because it also prevents effective indirect anterior cord decompression resulting from dorsal migration of the cord [22]. In addition, preexistent spinal instability may increase and lead to kyphosis progression [23–31]. Laminoplasty may lead to a worsening of neck pain, especially in patients with rheumatoid arthritis, which is a relative contraindication for laminoplasty [32].

Fig. 10.4 Patient positioning for cervical laminectomy/laminoplasty. The head is secured in the Mayfield skull clamp. When excessive venous bleeding is encountered, a reverse Trendelenburg maneuver is advisable

10.3 Surgical Technique

Cervical laminectomy may be performed via a conventional open midline dissection [33, 34] or transmuscular muscle dilation approaches [35]. Historically, the posterior midline approach to the cervical spine (C-spine) ranges among the earliest reported surgical techniques addressing the thoracolumbar and C-spine [36, 37].

- The patient is positioned prone on a stable spine frame, with the arms adducted to the body and secured in either towel slings or padded armrests. Exact alignment of the C-spine and reduction of deformity by careful traction combined with either flexion or extension must be confirmed by lateral fluoroscopy. When the ideal position is achieved, immobilization by a Mayfield skull clamp is advocated, as it allows for safe and effective cervical traction and reduction and this fixation technique also avoids pressure on facial soft tissues, thus minimizing the risk of visual deterioration infrequently observed after prolonged positioning in a horseshoe headrest (Fig. 10.4).
- The upper body and head as well as the lower limbs are elevated to facilitate venous drainage, reducing intraoperative blood loss. Brisk venous bleeding from the epidural plexus is readily controlled by temporarily elevating the operating table (reverse Trendelenburg posi-

tion), and local application of collagen sponge or another hemostatic agent. Lateral fluoroscopy is used to localize the target cervical spine segments and mark position and length of the skin incision. Manual palpation in case of laminectomy over several segments may also be used in patients with slim necks. The spinous process of the seventh cervical vertebra is usually prominent and well palpable and the first non-bifid subaxial cervical spinous process. Depending on C-spine morphology as well as specific requirements of the intended surgical procedure, skin incision length and the extent of soft tissue clearance from the C-spine need to account for the expected depth of the approach, i.e., a relatively longer incision is necessary in short bulky necks. Special attention should be directed at skin preparation and disinfection, because the skin of the neck region is particularly rich in sebaceous glands and in many individuals will form deep folds during lordotic positioning of the C-spine. One dose of broad spectrum antibiotics at induction, meticulous preoperative cleansing and draping of the operative field along with careful soft tissue handling, and liberal placement of drains preventing compressive postoperative hematomas and postoperative infections should be standard care.

- As a key principle remaining without major change from the early descriptions [38], a midline skin incision is performed with subsequent splitting of the nuchal ligament down to the spinous processes, followed by bilateral fascial release and subsequent subperiosteal dissection of the paraspinal muscles to expose the targeted laminae and lateral masses. In the cervical spine, there are no muscular or ligamentous attachments to the laminae. In contrast to the difficulties inherent in historic posterior surgical approaches to the C-spine, the use of modern dissection tools such as monopolar cautery or the harmonic scalpel (ultracision) has significantly reduced the amount of blood loss, typically associated with this procedure due to the abundance of vasculature in the soft tissue layers of the neck. Regardless of the availability of contemporary surgical tools, paying due attention to every detail of the surgical procedure is advisable to avoid potentially deleterious complications (Fig. 10.5).
- For simple decompressive laminectomy or laminoplasty without arthrodesis, full clearance of the paraspinal muscle bulk from the lateral masses is unnecessary, whereas muscle dissection needs to be carried to the very lateral border of the lateral masses for (instrumented) arthrodesis procedures (Fig. 10.5). In case of intended pedicle fixation of the C-spine, sufficient soft tissue release (i.e., one segment cranial and caudal to the target levels) is mandatory, to prevent interference of the paraspinal muscle bulk with the converging screw trajectories (Figs. 10.5 and 10.6). For this same reason, pedicle screw placement in the subaxial spine (C3–C6) usually requires accessory lateral stab incisions in order to follow the medial convergence angles of the C3–C6 pedicles, ranging between 45° and 55°. Instrumentation (especially pedicle screws) should be inserted prior to laminectomy to prevent inadvertent plunging of instruments into the spinal canal (see Chap. 14).

10.3.1 Open Midline Cervical Laminectomy Technique

- The laminae are disconnected bilaterally from the articular pillars using a 4 mm drill bit to thin out the lateral part of the lamina down to the inner cortical shell, followed by removal of the remaining inner cortical lamella with a flat-footed 3 mm Kerrison punch. Once the laminae are disconnected, they can be removed in one piece by grabbing the most cranial spinous process with a sharp-pointed (towel) clamp and pulling the laminae in a rostrocaudal direction away from the dural sac, separating the remaining bony or ligamentous adhesions with a 3 mm Kerrison punch. This technique requires the presence of an assistant surgeon to hold and pull the laminae and allows for safe, easy, quick, and blood-sparing

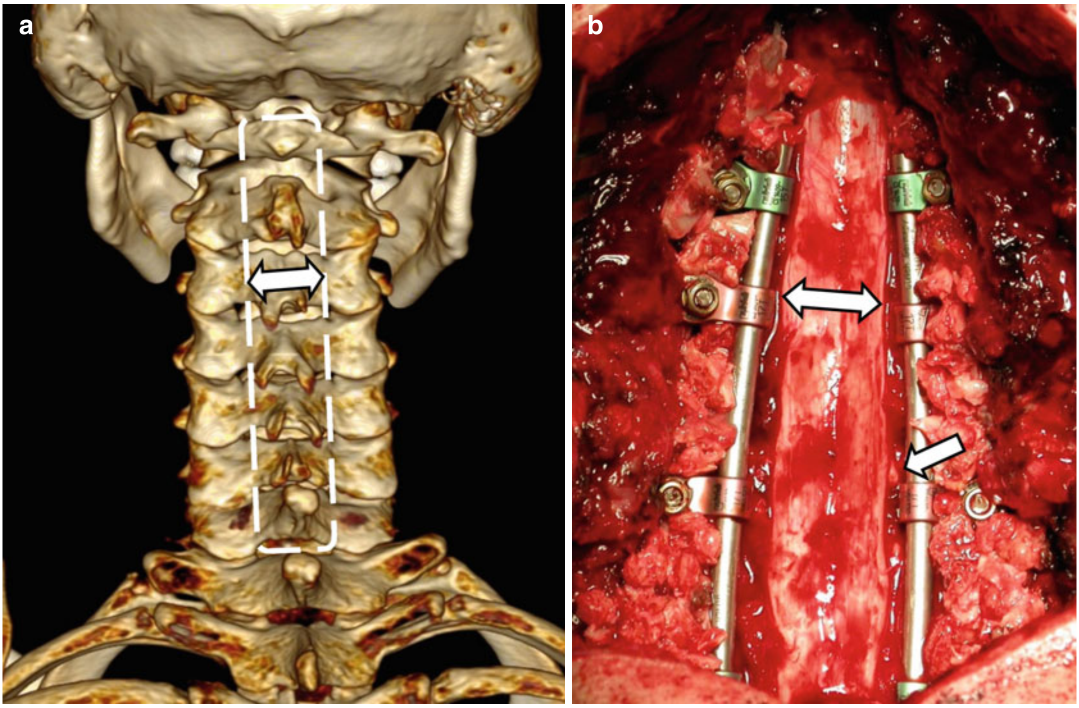

Fig. 10.5 (**a**) Three-dimensional reconstruction of cervical CT demonstrating posterior bony anatomy relevant to laminectomy and laminoplasty techniques. The *white interrupted line box* indicates the required lateral extension of decompression required to adequately release the cervical cord in multisegmental stenosis. (**b**) Intraoperative image following multisegmental cervical laminectomy (C2–C7) and instrumented fusion. Full release of the cervical thecal sac is obtained after full laminar removal, with the lateral circumference of the thecal sac (*double-headed arrow*) and exiting cervical roots (*single arrow*) become visible

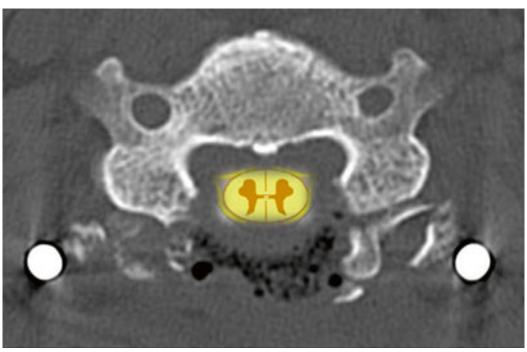

Fig. 10.6 Postoperative axial CT following cervical laminectomy, clearly demonstrating complete posterior decompression by removal of the lamina out to the articular pillars, allowing the cord (as outlined by schematic image overlay) to move posteriorly away from anterior compressing spondylotic spurs. Note the autologous bone graft placed on the lateral masses. A gelatin sponge has been inserted covering the laminectomy to prevent bone chips from dislodging into the exposed spinal canal

removal of several cervical laminae in one piece. If desired, the laminae removed in this fashion may be refixed to the articular pillars using titanium miniplates (i.e., laminoplasty, see below). Undercutting of laminae suprajacent but especially infrajacent to the laminectomy site can be performed to maximize spinal canal decompression without sacrificing the stability of adjacent segments.

10.3.2 Paramedian Muscle-Splitting Approach Technique

- In posterior muscle-sparing approaches to the cervical spine, sequential tissue dilation and tubular retractor systems are used in the same manner as in MIS lumbar laminectomy and MIS posterior cervical foraminotomy. Following fluoroscopic-guided placement of the tubular retractor system on the target laminae, either uni- or bilaterally (Fig. 10.7), laminectomy may be performed similar to conventional open technique, although the technique as described above is not possible. Alternatively, the dorsal part of the spinous processes and lateral outer cortical shell of the contralateral hemilaminae may be left intact by using an undercutting technique via a unilateral access [35]. This technique has been described in this book for the lumbar spine (see Chap. 32).

- Regardless of the type of approach outlined above, venous oozing from the lateral gutter, next to the dural sac, is a sign of sufficient spinal decompression and is most efficiently controlled by gentle packing with thin strips of collagen sponge or gentle bipolar coagulation, continuously irrigated with saline. The dural sac as well as the spinal cord usually begins to pulsate visibly, once maximally decompressed. In our opinion there is no need for additional cutting of the intradural dentate ligaments in an attempt to obtain further spinal cord release. Moreover no evidence exists that this maneuver is beneficial. It adds, however, some extra complications to this procedure. If present, foraminal stenosis is addressed by unroofing the respective cervical nerve root canal until the entire course of the entrapped root, from its dural take-off laterally to the foraminal exit zone, can be freely sounded with a fine nerve hook. Remember that the position of the C-spine during surgery is often not the same as in an upright or even extended position. Ample space in the neuroforamen therefore should be provided in this intraoperative situation.
- After confirmation of adequate decompression, the operative field is generously irrigated and meticulous hemostasis obtained. We prefer to cover the decompressed spinal canal with a hemostatic sponge before wound closure. This sponge might offer several effects: (a) reducing

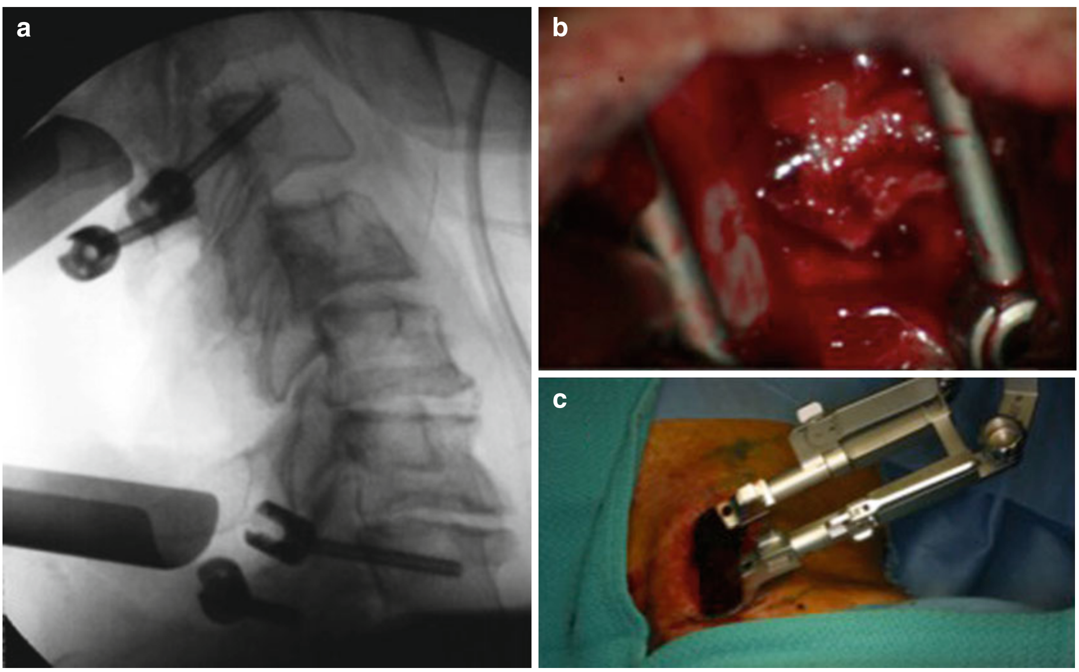

Fig. 10.7 (**a**) Intraoperative lateral fluoroscopy during posterior cervical decompression and instrumented fusion through a unilateral transmuscular approach using an expandable tubular retractor. (**b**) Intraoperative view through the operating microscope in the same patient demonstrating the decompressed cervical thecal sac and instrumentation (combination of translaminar and pedicle screws inserted through the unilateral approach) in place. (**c**) View of surgical site with expandable tubular retractor in place, fixed to the operating table by a flex arm

postoperative intraspinal hematoma and, potentially, scar formation, (b) serve as distinct radiolucent layer between paraspinal muscles and the spinal canal that allows for clear visualization of the dural sac in case of postoperative imaging, and (c) effectively preventing bone chips from dislodging into the spinal canal in arthrodesis procedures.

- When additional bony fusion is desired, adequate decortication of the fusion bed (i.e., the posterior surface of the articular pillars) and sufficient grafting using autologous bone chips (usually harvested during spinous process takedown) is essential.

10.3.3 Cervical Laminoplasty

Laminoplasty was predominantly developed in Japan in the 1970, mainly because in the Western part of the world, potential complications of laminectomy and posterior instrumented arthrodesis were feared. Various techniques for laminoplasty have been devised, but they all involve preservation of the lamina and decompression of the spinal cord by partially or completely detaching the lamina and by repositioning them more posteriorly (See Chap. 11). It was thought that laminoplasty would reduce the number of complications associated with postoperative spinal instability and deformity because we assumed it would preserve the posterior elements of the cervical spine. Furthermore, cervical laminoplasty was designed to enlarge the spinal canal without the need for removal of the laminae, thus protecting the dura from scar formation and preserving postoperative cervical stability, alignment, and motion of the decompressed cervical segments and reducing postoperative pain as compared to laminectomy. Moreover, since some bony attachments of the neck muscles remain intact, a potentially more physiological restoration of paraspinal muscle function has been claimed as a major advantage over standard laminectomy, especially in children and young adults (usually treated for disorders of the cervical spinal cord such as tumors and malformations). However, compelling evidence for these notions has never been demonstrated. Neurological outcome and change in spinal alignment are similar after laminectomy and laminoplasty [39]. Moreover, loss of (at least partial) segmental motion over time and persistence of neck and shoulder pain, as well as potential subsequent progression to kyphosis, have been observed [8, 9, 39–41]. Functional impairment after laminoplasty versus laminectomy may thus be rather related to the underlying disease of the cervical spine [39, 40]. Following fundamental principles in deriving the indication for posterior versus anterior decompression, laminoplasty should be avoided in patients with straight or kyphotic C-spines and anteriorly located compression of the spinal cord (Fig. 10.8).

Numerous technical variants of cervical laminoplasty have been reported, with the first description of the technique in the treatment for OPLL dating back to 1973 [42]. This initial expansive laminoplasty procedure ("Z-plasty" of the cervical spine) incorporated removal of the spinous processes, thinning the bone at the lamina-facet junction and conducting a Z-shaped cut to open the laminae (Fig. 10.9), which were then fixed with sutures or wire [42]. Subsequent refinements in laminoplasty technique consisted of alternative laminar and spinous process cutting (e.g., "open door," "double door") and securing the laminae in an open position by wires or heavy sutures, autologous and allogenous bone or hydroxyapatite blocks, miniplates, or combinations of the above [27, 43–52]. No specific technique has been demonstrated to enhance clinical safety or efficacy. In more recent techniques, a hinge is created on one side of the lamina-spinous process-ligamentum flavum complex [53]. This allows the roof of the canal to be opened on the contralateral side where the laminae are completely disconnected from the articular pillars, leading to an expansion of the spinal canal. For the description of this technique, we refer to Chap. 11.

- Analogous to laminectomy, caution is advisable at the superior aspect of the lamina, where there is no yellow ligament to protect the dural sleeve. The bony troughs, created rostral to caudal from one level above to one

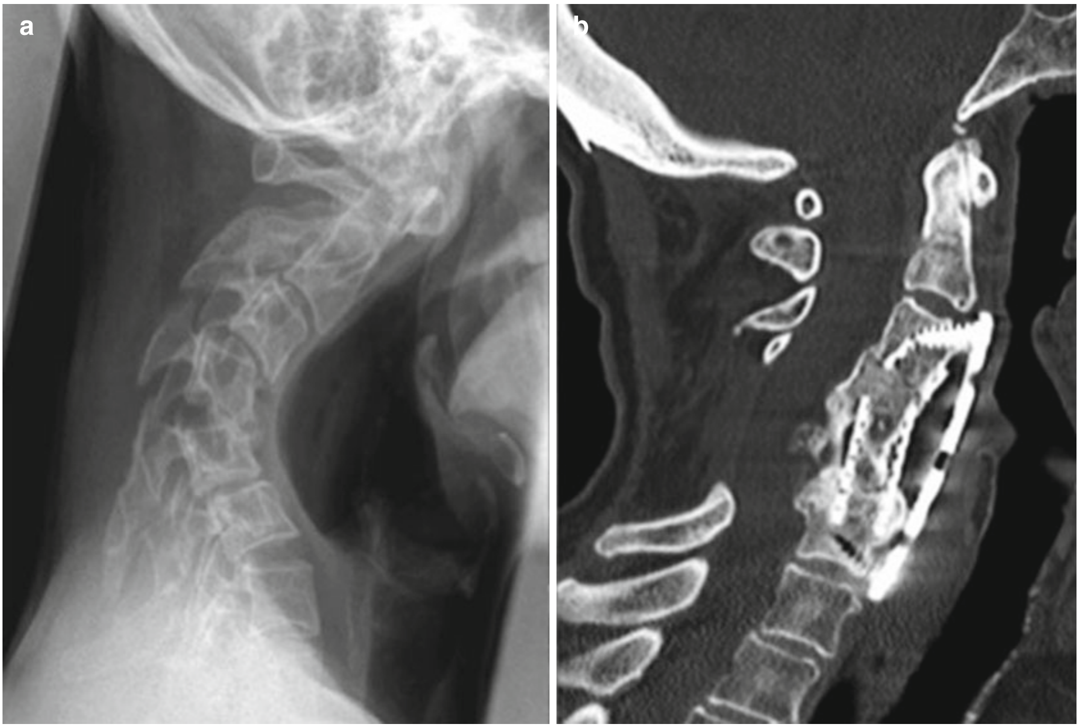

Fig. 10.8 (**a**) Lateral X-ray demonstrating severe post-laminectomy kyphosis in a 32-year-old patient secondary to removal of intradural extramedullary tumors in neurofibromatosis type II. (**b**) Sagittal CT reconstruction in a 69-year-old female sequentially treated for cervical spondylotic myelopathy. Index surgery consisted of non-instrumented laminectomy in a moderately kyphotic spine, followed by marginal improvement of myelopathic signs. In a second-stage surgery 1 year later, anterior decompression was performed by ACDF C3/C4 and corpectomy with vertebral body replacement C5 complemented by anterior plating. Cervical lordosis was initially restored. The actual follow-up CT 2 years later shows failure of anterior instrumentation due to significant subsidence of the titanium mesh cage, recurrent kyphosis, and anterior cord compression by dislocation of a bone fragment, causing delayed clinical deterioration. This case clearly illustrates the need for instrumented fusion in patients with preexistent kyphosis undergoing posterior decompression

level below the stenotic levels, should be perpendicular to the lamina. A 6 mm diamond burr is useful to cut the external laminar cortex in the process of creating a greenstick fracture on the hinged side. This technique reduces the risk of inadvertently penetrating the inner cortex of the lamina. In addition, the 6 mm drill bit creates a wider trough on the hinge side, facilitating subsequent opening of the laminoplasty door and, therefore, improving decompression.
- The depth of the lamina on the opened side is used as reference for how deep the trough should be on the hinged side. The facet joints should not be violated to prevent instability and kyphosis.
- Foraminotomies are performed using the surgical microscope prior to opening the hinges.
- After sufficiently thinning out the bony hinge, the posterior elements become flexible enough to gradually open the laminar gap, lifting the spinous process toward the hinged side and the lamina off the spinal cord using a curette on the opening side.
- Opening multiple laminae as a unit with preserved inter- and supraspinous ligament helps to preserve stability of the spine.
- As in laminectomy, once the dural sleeve is observed to start pulsating (usually after lifting the hinge to create a gap of 6–10 mm), adequate expansion of the spinal canal has been obtained.

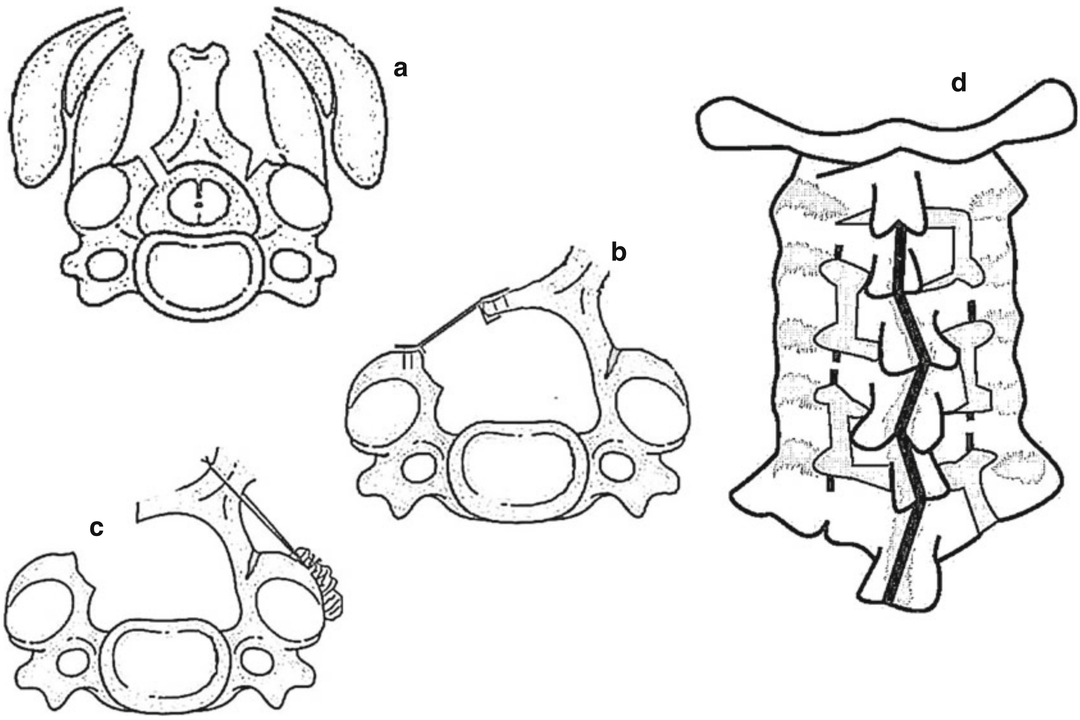

Fig. 10.9 (**a**) Laminoplasty with through cut of the lamina at the left and "hinge" made by a high-speed drill at the outer cortex at the left. (**b**) Fixation of the lamina to the lateral mass with a plate. (**c**) Fixation of the lamina by wiring of the spinous process. (**d**) "Z" laminoplasty as described by Oyama

- Hemostasis is achieved with a hemostatic sponge and bipolar cautery. The resulting opening of the spinal canal is secured by either the insertion of spacers/plates between the disconnected laminae and corresponding lateral masses or fixing the lamina to the lateral masses on the opened side using heavy nonabsorbable sutures or wires [43, 44, 46, 48, 54, 55].

Alternative laminoplasty techniques have been devised, with either midline splitting of the bilaterally hinged spinous processes ("double door" technique) or bilateral laminar detachment and subsequent insertion of spacers in the lamina articular pillar gap [45, 49, 56]. A potential advantage of the "double door" over the "open door" techniques is reduced bleeding from the epidural venous plexus.

- Postoperatively, in all posterior cervical procedures, the head of the bed should be elevated (30–40°) to enhance venous return, reduce cervical soft tissue swelling, and minimize venous bleeding. An aspirative drain should be left in place for at least 24 h to prevent a compressive hematoma. We advise that patients are immobilized in a rigid cervical collar for 3–4 weeks and that they may return to regular daily activities as soon as possible. After discontinuing their collar, isometric neck exercise is initiated.

10.3.4 Complications Avoidance and Management

In both laminectomy and laminoplasty, spinal cord and nerve roots (specifically, C5) can be mechanically injured, specifically during decompression using a broad-footed punch in high-degree cervical stenosis. Isolated nerve root injuries (primarily, motor weakness) may occur in up to 11 % [57, 58]. The underlying mechanism of C5 nerve root palsy remains elusive. However, it is likely caused by either direct compression on the hinge side (particularly when preoperative neuroforaminal stenosis is not adequately addressed during surgery) or traction injury, as the C5 roots are:

- Located at the apex of the lordotic cervical curve and thus the center of most laminectomies/laminoplasties.
- Shorter and less forgiving to traction injuries [57–60].
- In direct contact with their corresponding disk, most of the time covered with compressive osteophytes. This explains why in anterior approaches, also the C5 nerve root is affected more than the others.

Intraoperative motor evoked potential and EMG monitoring may be used to reduce the risk of neurological complications during posterior cervical decompression. At all times, during the decompression surgery, a mean arterial pressure of 85 mmHg is considered to be beneficial for the neurological outcome and therefore is advised.

10.4 Tips and Tricks

- Proper preoperative planning, avoiding contraindications as outlined above, as well as a proper choice between an anterior and posterior approach should be considered for every individual patient (see “Editor’s Note on Evidence”).
- Adequate positioning of the patient during surgery in a 30° reverse Trendelenburg position is important to augment venous return and reduce bleeding from the soft tissues of the neck and the spinal epidural venous plexus.
- The head should be slightly flexed and secured in a Mayfield skull clamp and the cervical spine should be in a neutral position in the coronal plane to maximize interlaminar and interspinous space and to open the facet joints during foraminotomy.
- When additional posterior instrumentation and arthrodesis is planned, a slight extension of the neck during positioning or prior to fixation is necessary to restore the physiological sagittal alignment of the cervical spine and avoid fusion in a kyphotic position.
- Careful preoperative skin preparation (doubling the disinfection time) and gentle skin and soft tissue handling during surgery in order to reduce deep wound infection is mandatory.
- In order to avoid excessive bleeding, the surgeon should maintain a subperiosteal plane of dissection during exposure of the posterior cervical spine, using a blunt periosteal elevator and monopolar cautery.
- Careful (two-handed) use of a 2–3 mm flat-footed Kerrison-type punch is recommended to remove the inner laminar cortex in laminectomy/laminoplasty and during foraminotomy to prevent undue pressure on the spinal cord and roots.
- When unexpected hypermobility of the C-spine becomes evident during surgery, instrumented posterior fixation is strongly advised to prevent clinical deterioration due to postoperative instability or kyphosis.
- Adequate surgeon training, skills, and experience are prerequisite for safe and efficient application of MIS in clinical practice.

10.5 Comments on Evidence

10.5.1 Anterior Versus Posterior Approach for the Treatment of CSM

When used within the appropriate indication limits, a recent prospective multicenter study showed that laminectomy and laminoplasty yield similarly high neurological recovery rates of 50–90 % as compared to anterior decompression techniques [3, 7, 20, 23, 25, 43, 55, 57, 61–67]. Long-term studies have revealed a moderate rate of neurological decline, postoperative radiculopathy, kyphotic deformity, and loss of motion [3, 7, 30, 62] after laminectomy.

A significantly higher incidence of neck pain has been observed after laminoplasty as compared to multilevel anterior cervical decompression and fusion (ACDF)/corpectomy [39, 63]. Postoperative neck pain is thought to be related to dissection around the facets and soft tissue retraction, necrosis, scarring, and progressive kyphotic deformity with or without instability [41, 58] Anterior decompression procedures, however, increase the rate of adjacent segment degeneration (secondary spondylosis) in contrast to laminoplasty [68].

Multilevel corpectomy and laminectomy with additional instrumentation both carry a significantly higher risk of graft, instrumentation, and approach-related complications [1, 3–7, 69]. Multilevel corpectomy and laminectomy with arthrodesis lead to significant decreases in cervical mobility, whereas motion is (at least partially) retained after laminoplasty. However, numerous studies have reported an average of 50 % reduction of the cervical range of motion after laminoplasty [24, 25, 27, 29, 30, 44, 47, 52, 55, 57, 62, 70–73]. Although radiographically evident, the clinical significance of cervical motion preservation as well as that of adjacent level disease, however, remains unclear.

Posterior approaches to the cervical spine may be particularly successful in geriatric individuals in whom the cervical lordotic curvature has been well preserved. However, they are inappropriate for both older and younger patients with predominantly anterior spinal cord compression and/or straight or kyphotic C-spines [7, 74]. A clear relationship between post-laminectomy/laminotomy kyphotic deformity and clinical or neurological outcome has not been convincingly established [62, 64, 71, 75]. In contrast, the etiology of stenosis appears to impact the prognosis of laminoplasty. Patients with OPLL more frequently develop late clinical deterioration as compared to those treated for CSM [1, 57].

Studies comparing laminectomy and laminotomy in the treatment of CSM yield conflicting results. One study has shown both reduction in postoperative cervical pain and range of motion after laminoplasty [76]; these findings have, however, not been confirmed by others [23, 50, 77]. There is some evidence that laminoplasty yields a more favorable surgical risk profile than laminectomy with arthrodesis or anterior decompression (corpectomy) in the treatment of CSM [25, 63, 71, 78].

Editor's Note on Evidence

Cervical spondylotic myelopathy (CSM) is a degenerative disorder with an unfavorable natural history. The most important predictors of outcome after surgical treatment are preoperative severity and duration of symptoms [79].

For this chapter, based on a recent review of the literature, a claim of superiority for laminoplasty over laminectomy is not justified. On the contrary, a higher number of procedure-related complications when performing laminoplasty are reported.

In general, when treating CSM, surgical options have been evolved substantially over time with both anterior and posterior approaches [80]. Although in the current literature no evidence exists about the superiority of one approach over another, understanding the pros and cons of the different approaches might be critical for the surgeon to select the most appropriate surgical technique for the individual patient. Multiple decision-making factors are involved (Fig. 10.10).

This flow chart may help in selecting the most appropriate surgical strategy when dealing with a patient presenting with CSM (Fig. 10.10). This flow chart is not based on existing evidence, due to the lack of it.

This flow chart summarizes the clinical guidelines I propose for the most appropriate surgical approach when dealing with CSM.

With "shape of patho-anatomy," I mean the anterior compression of the spinal cord; when flat, a posterior approach seems most appropriate, when only at the level of the discs, an anterior decompression is preferred [81].

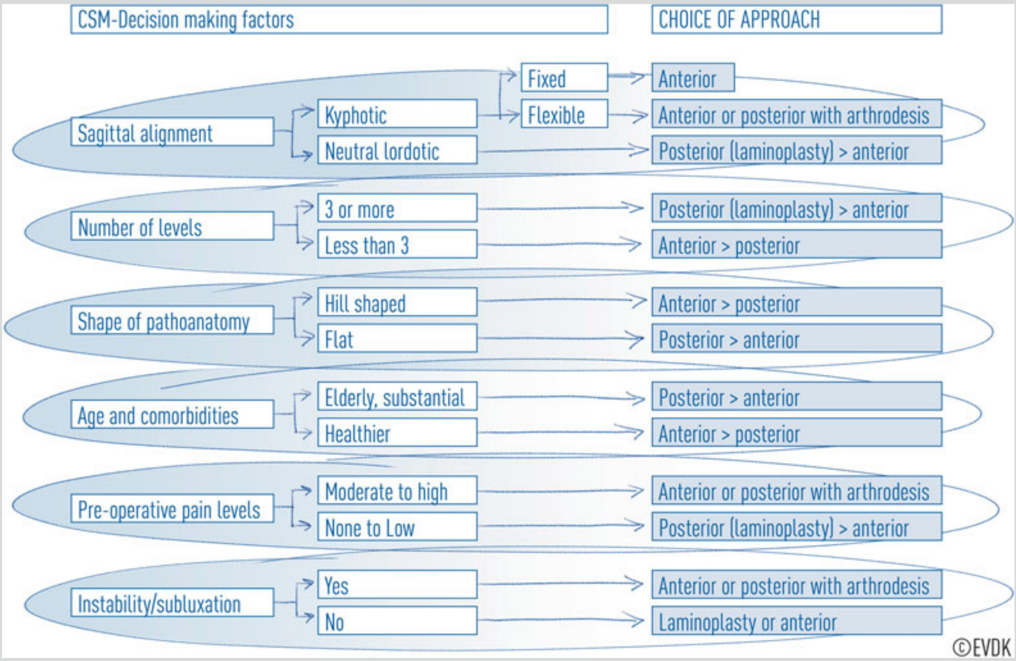

Fig. 10.10 Algorithm suggesting the most appropriate surgical approach with respect to various preoperative parameters (From Emery Eur Spine J 2016 reprinted with permission of the publisher)

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