# 56 Ventral and Ventrolateral Subaxial Decompression

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## SUMMARY OF KEY POINTS

- The ventral approach is appropriate for a discectomy, corpectomy, fusion, and instrumentation.
- The ventrolateral approach is also appropriate for a decompression of the vertebral artery.
- Intraoperative neuromonitoring is controversial with respect to improved outcome after cervical decompressive surgery.
- Dysphagia is a common occurrence after ventral cervical surgery and is transient.
- Hoarseness is a common occurrence after ventral cervical surgery and is usually transient.
- The sympathetic trunk is more prone to injury with a ventrolateral approach.
- A complete decompression is required before insertion of the interbody graft.
- Patients take longer to recover from myelopathic symptoms than from radicular symptoms.

Ventral compression of the spinal cord or the nerve roots is the most common indication for ventral decompression. Clinical conditions such as cervical trauma with ventral disc herniation or bone fragments, acute cervical disc herniation, cervical spondylosis, ossification of the posterior longitudinal ligament, neoplastic processes, and infection can all be successfully managed by a ventral decompressive technique. A ventrolateral decompression may be required for vertebral artery stenosis secondary to tumor, spondylosis, or compression of the cervical nerve roots. Although these decompressive measures are effective and generally safe, they nevertheless may be associated with a number of complications that can be serious and even devastating. Ventral cervical discectomy, often considered relatively safe and simple, is one of the most common procedures involved in malpractice litigation.

## GENERAL CONSIDERATIONS

The first step for avoiding complications associated with any surgical procedure is to perform the appropriate operation on the appropriate patient. Although a detailed discussion of various indications for surgery and criteria for patient selection is beyond the scope of this chapter, the importance of correlating the clinical picture with the imaging abnormalities cannot be overemphasized. The majority of middle-aged patients will have at least some degree of degenerative changes of the cervical spine, but only a few will have symptomatic spinal cord or nerve root compression. Therefore, a careful analysis of patient history and meticulous neurologic examination are essential to accurately correlate the imaging abnormalities with the patient's clinical picture.

The ventral decompression approach to the cervical spine is performed through a plane between the sternocleidomastoid muscle and the carotid sheath laterally and the strap muscles and tracheoesophageal viscera medially. This approach is appropriate for ventral cervical discectomy, vertebrectomy, fusion, and instrumentation (Fig. 56-1).

The ventrolateral approach, on the other hand, is more suitable for decompression of the vertebral artery in the transverse foramen or between the foramina or spinal nerve roots outside the spinal canal. Two different techniques are described in the literature. Verbiest's[1] technique is performed through the same plane as the ventral approach. However, further exposure is performed lateral to the longus colli muscle on the ipsilateral side. This exposure allows visualization of the costotransverse lamella, which forms the roof of the foramen transversarium covering the vertebral artery. Hodgson,[2] on the other hand, approached the cervical spine lateral to the sternocleidomastoid muscle and the carotid sheath. These structures, along with the musculovisceral column, are retracted medially (Fig. 56-2). The remainder of the exposure is similar to that described by Verbiest, with the exception that the longus colli muscles are retracted medially to laterally to gain access to the vertebral artery.

Essentially, the structures at risk of injury are the same with either the ventral or the ventrolateral approach. In Hodgson's approach, the tracheoesophageal viscera and recurrent laryngeal nerve (RLN) are protected, whereas the nerve roots, sympathetic chain, and vertebral artery are at greater risk.

## SPECIFIC COMPLICATIONS, AVOIDANCE, AND MANAGEMENT

### Preoperative Period

In patients with a significant neurologic deficit, the preoperative use of corticosteroids may be considered. However, there are no convincing data in the literature to support the efficacy of the routine use of corticosteroids in patients undergoing decompressive operation.

Although hyperextension of the neck usually facilitates exposure during the operation and restores normal lordotic curvature of the cervical spine, excessive hyperextension during intubation or during the operative procedure may further narrow the spinal canal and exacerbate a preexisting neurologic deficit, especially in patients with spinal canal compromise. The amount of hyperextension that the patient can tolerate can be assessed in the preoperative period by placing the neck in the amount of extension anticipated during the operation or intubation. If the patient can maintain this position for 30 minutes without motor or sensory symptoms, the operation can be performed safely in that position. If, however, any symptoms are induced during the testing, the neck must be kept neutral throughout surgery and the patient may need to be intubated fiberoptically.

Intraoperative evoked potential monitoring can be used to identify and avoid dangerous manipulation of the neural tissue during surgery.[3] However, there is currently no convincing evidence that the use of this modality improves outcome after decompressive surgery. Somatosensory evoked potentials (SSEPs) are most commonly used for this purpose. However, this type of monitoring may be associated with false-positive intraoperative SSEP changes, thus creating significant anxiety

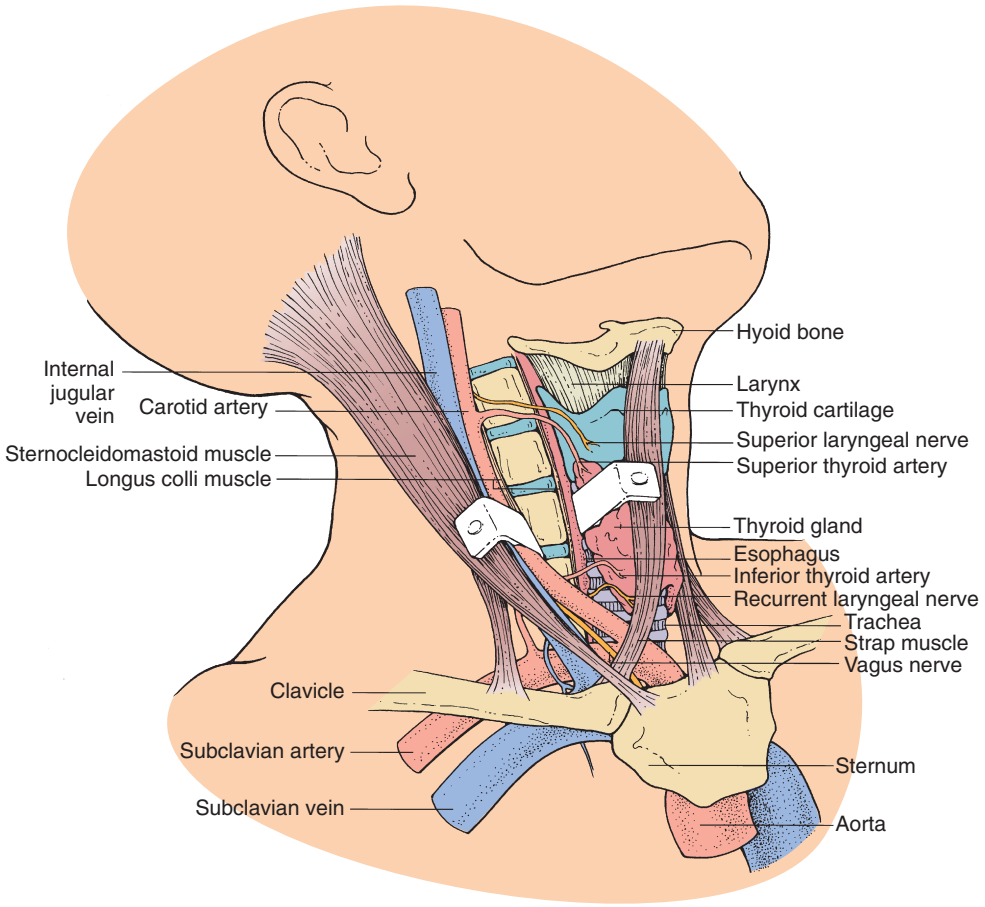


**Figure 56-1.** Ventral exposure of the cervical spine and anatomic structures of surgical importance.

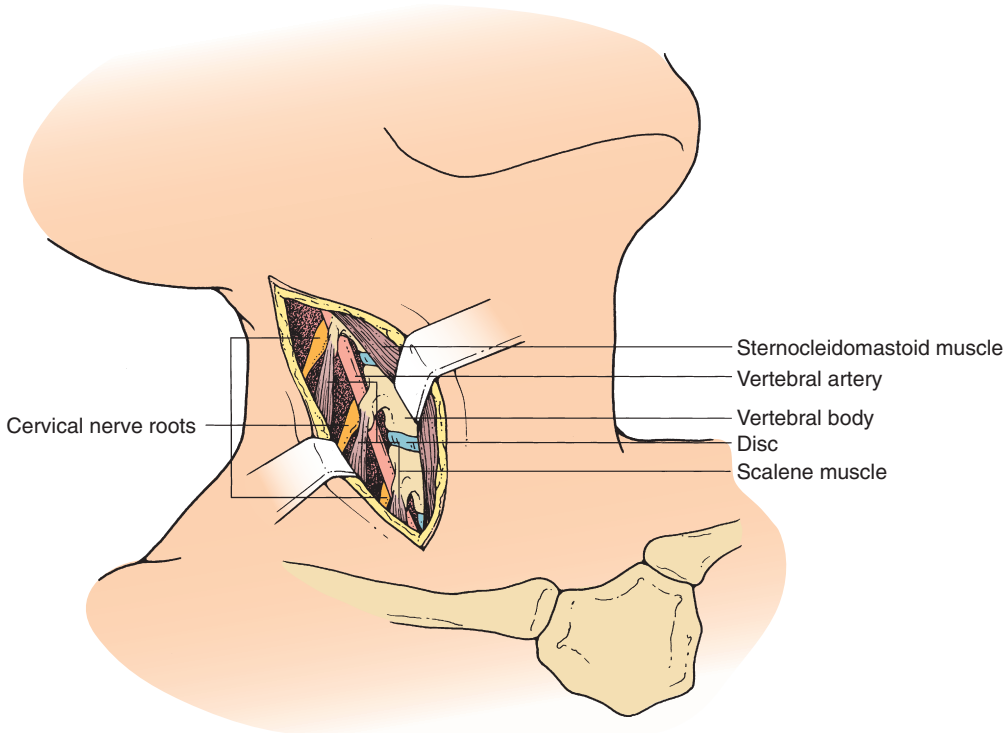


**Figure 56-2.** Ventrolateral exposure of the cervical spine as described by Hodgson.

for the surgeon and possibly unnecessary anesthetic and surgical maneuvers. Motor evoked potential monitoring reflects the function of the ventral spinal cord tracts more reliably than does SSEP monitoring and may avoid some of the false-positive intraoperative changes observed with SSEPs.

To facilitate identification of the lower cervical segments on the localizing radiograph, caudal traction is applied to the shoulders or arms. In this case, excessive traction should be avoided because there is potential risk for traction injury of the upper brachial plexus.

## Intraoperative Period

A right-sided approach is generally recommended because it is easier for the right-handed surgeon. Some authors, however, believe that a right-sided approach is associated with higher risk of injury to the RLN, especially in the lower cervical spine. The risk, however, is low.

The risk is probably balanced by the convenience of the position for right-handed surgeons. A left-sided approach, on the other hand, carries the risk of injury to the thoracic duct during exposure of the lower cervical spine. A review of 328 patients who underwent ventral cervical spine fusion procedures showed no association between the side of the approach and the incidence of RLN symptoms.[4]

The skin incision is usually transverse and localized in a skin crease. Alternatively, a diagonal skin incision along the medial border of the sternocleidomastoid muscle may be used for multilevel disease. After the skin incision is made, the platysma muscle is dissected both rostrally and caudally. One should look for branches of the external jugular vein, because these may be inadvertently transected with sharp scissors during the dissection. If identified, the blood vessels can be coagulated and sharply divided. The platysma is then incised vertically parallel to its fibers throughout the limits of the exposure to prevent undue traction.

For a ventrolateral approach, more complete exposure of the sternocleidomastoid muscle is required. During the opening of the ventral cervical fascia, the greater auricular nerve and other ventral cutaneous nerves are at risk of injury. Injury to the greater auricular nerve results in decreased sensation of the skin of the face in the area of the parotid gland. This nerve penetrates the deep fascia on the dorsal surface of the sternocleidomastoid muscle at approximately midbelly and travels rostrally on the surface of the sternocleidomastoid muscle toward the ear. The anterior cutaneous nerve, on the other hand, takes a more horizontal course across the sternocleidomastoid muscle before dividing into ascending and descending branches. The ascending branch provides cutaneous innervation of the skin overlying the mandible. Damage to this nerve can result in decreased sensation over the mandible. The key to avoiding injuries to these structures is to identify them and to be aware of their anatomic location.

During lateral retraction of the sternocleidomastoid muscle for a ventrolateral approach, the eleventh cranial nerve is also at risk of injury and must be identified. This nerve enters the sternocleidomastoid muscle two to three finger-widths below the mastoid tip and exits the muscle obliquely, caudally passing across the posterior triangle of the neck to the ventral border of the trapezius muscle.

After the superficial cervical fascia is incised and the plane is developed between the sternocleidomastoid muscle laterally and the strap muscles medially, certain structures are at risk of injury. These include the larynx and trachea, esophagus and pharynx, laryngeal nerves, carotid artery, internal jugular vein, vagus nerve, sympathetic chain, and pleura. The complications related to these structures are discussed separately.

### Injury to the Larynx and Trachea

Perforation of the trachea, though a rare and unusual complication of this procedure, can occur during medial dissection. If it does occur, direct repair is usually possible. Severe laryngeal retraction can result in significant laryngeal edema that may appear as an immediate postoperative emergency. Many measures can be undertaken to reduce the severity of the postoperative glottic edema, including systemic corticosteroids, cold mist, and inhalation of racemic epinephrine. If these measures are not successful, reintubation may be attempted. If these maneuvers fail, a tracheotomy may need to be performed.

### Injury to the Esophagus and Pharynx

Dysphagia is a common problem after ventral cervical surgery and is usually secondary to edema from retraction. This symptom usually resolves within a few days without any treatment. In certain cases, however, it may persist as long as several weeks; rarely, it may be permanent. It is more common in elderly patients and in those who had extensive mobilization of the upper esophagus or hypopharynx. In a questionnaire mailed to 497 patients who had undergone ventral cervical fusion procedures, 60% reported some dysphagia after the surgical procedure compared to 23% in the control group.[5]

Esophageal or pharyngeal lacerations can occur, especially in the upper cervical region where the hypopharynx is thinner, either from sharp dissection or from the teeth of self-retaining retractors. Blunt finger dissection to mobilize the esophagus and expose the anterior aspect of the vertebral column will minimize the chance of esophageal penetration; repair often requires the assistance of a head and neck surgeon. If esophageal perforation is recognized intraoperatively, it should be repaired primarily. The wound should be drained and the patient placed on nasogastric drainage for at least 7 to 10 days. Fusion in these circumstances is frequently contraindicated. Subsequently, a swallow study with a water-soluble contrast agent should be obtained to confirm that the perforation has sealed. In the majority of cases, the injury to the esophagus is not recognized during surgery and shows symptoms later as a local infection, fistula, sepsis, or mediastinitis.[6,7] The presence of crepitus or an enlarging mass in the neck or mediastinal air on a chest radiograph usually suggests the strong possibility of an esophageal perforation. Diagnosis can be confirmed with an esophagogram. However, this test may not always be positive when esophageal injury is present. Esophagoscopy or a postesophagogram computed tomography (CT) scan may also demonstrate a perforation. Treatment of a delayed perforation consists of nasogastric drainage, antibiotics, and reexploration of the incision. If a defect is found, it should be repaired and a wound drain placed.[6] To avoid this complication, the longus colli muscles should be freed enough rostrally, caudally, and laterally so that the sharp teeth of the self-retaining retractors can be placed safely under them without risk of dislodgement during the procedure (Fig. 56-3). In addition, the esophagus and other soft tissue structures should be hidden by the retractors to avoid injury by the high-speed drill during bone removal.

Occasionally, perforation of the esophagus can result from a displaced graft.[8] To avoid this problem, some surgeons recommend reapproximation of the longus colli muscles over the graft. When a displaced graft perforates the esophagus, reexploration is required. Either replacement or removal of the graft may be indicated, depending on the need for the graft to maintain stability. The esophageal perforation should be repaired, if possible, and the patient treated with antibiotics and nasogastric drainage.

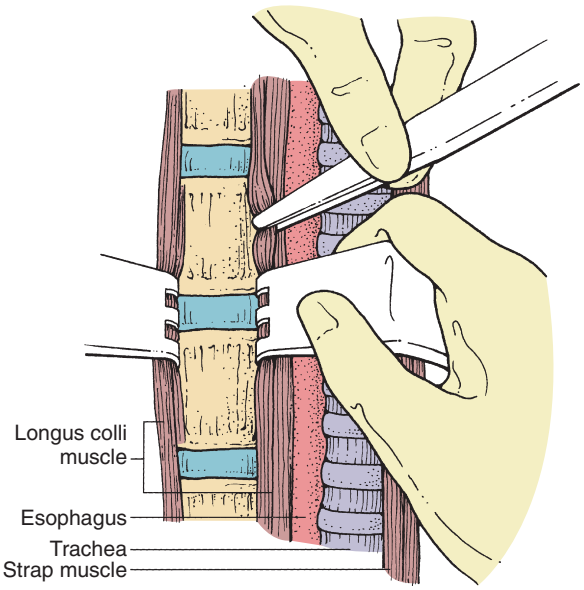


**Figure 56-3.** Placement of self-retaining retractors under the longus colli muscle to prevent dislodgement during surgery.

## Injury to the Laryngeal Nerves

Minor hoarseness or sore throat after a ventral cervical operation is common; it has been reported in approximately 50% of patients. It resolves without further intervention in weeks or months in the majority of patients. The cause is usually edema from tracheal intubation. However, injury to the laryngeal nerves can also occur and may result in permanent laryngeal dysfunction.

Both the superior and inferior (recurrent) laryngeal nerves are at risk during exposure of the ventral cervical spine. Some proposed mechanisms of this complication include direct surgical trauma, nerve division or ligature, pressure or stretch-induced neurapraxia, and postoperative edema.

The superior laryngeal nerve is a branch of the inferior ganglion of the vagus nerve and innervates the cricothyroid muscle. The superior thyroid artery, encountered above C4, is an important anatomic landmark for the superior laryngeal nerve. Damage to this nerve may result in hoarseness, but it often produces symptoms such as easy voice fatigue.[9] To avoid injury to this nerve, one should be aware of its anatomic location.

On the left side, the inferior (recurrent) laryngeal nerve loops under the arch of the aorta and is protected in the left tracheoesophageal groove. On the right side, however, the RLN travels around the subclavian artery, passing dorsomedially to the side of the trachea and esophagus. It is vulnerable as it passes from the subclavian artery to the right tracheoesophageal groove. The inferior thyroid artery on the right side is an anatomic marker for the RLN. The nerve usually enters the tracheoesophageal groove, the point at which the inferior thyroid artery enters the lower pole of the thyroid. Damage to the RLN may result in hoarseness, vocal breathiness or fatigue, weak cough, dysphagia, or aspiration.[10]

Preoperative insertion of a nasogastric tube not only allows easier identification of the esophagus for protection against an esophageal injury, but also allows localization of the tracheoesophageal groove and the avoidance of the plane. Endotracheal tube-related RLN injury has also been cited. Monitoring of the endotracheal cuff pressure and its release after retractor placement decreased the rate of RLN temporary paralysis from 6.4% to 1.7% in one series.[11]

One should also be aware of the anatomic variations, especially on the right side, where the RLN may be nonrecurrent. However, the frequency of this aberration is well below 1%.[12] In this situation, the RLN travels directly from the vagus nerve and the carotid sheath to the larynx. If a suspected nonrecurrent nerve is encountered, it may be identified with a nerve stimulator and laryngoscopic examination of the vocal cords. If it cannot be retracted safely, it is best to abandon the procedure and use a left-sided approach.

The RLN is better protected during Hodgson's approach than it is during a standard ventral cervical approach. However, it should be kept in mind that this nerve is still vulnerable at the position at which it enters the right tracheoesophageal groove. It is important to remember that during Hodgson's procedure, the midline is first identified after the prevertebral fascia is incised and the longus colli muscle retracted from medial to lateral position. The key to avoiding injury to the important anatomic structures during Hodgson's approach is to recognize that the approach is lateral to the sternocleidomastoid muscle, as well as to the carotid sheath. However, during the opening of the prevertebral fascia, the midline is identified, and the longus colli muscles are retracted medially to laterally.

The true incidence of RLN injury is difficult to determine but is probably about 1% to 2%.[4,13] Beutler and colleagues[4] reported that the incidence of RLN symptoms was 2.1% with anterior cervical discectomy, 3.5% with corpectomy, 3% with instrumentation, and 9.5% with reoperative anterior surgery.

Because many patients have some degree of voice change after ventral cervical operations, a thorough investigation is not required in most cases. However, a laryngoscopic examination should be performed in persistent cases. If RLN palsy is present, the vocal cord will be fixed in the paramedian position. Immediate treatment is not usually required for a paralyzed vocal cord because, in most instances, the nerve has not been severed, and the condition will resolve with time.[13] In some patients, hoarseness or voice dysfunction may be minimal, not requiring treatment. However, patients with persistent hoarseness after several months can be treated with injections of hemostatic gelatin (Gelfoam) or Teflon into the vocal cord. Gelfoam produces a temporary improvement and may be used as an interim measure pending spontaneous return of function. Teflon injection is a permanent treatment modality that is used in patients in whom no recovery is expected. Patients who are undergoing reoperation using an anterior contralateral approach should have preoperative laryngoscopic examination to preclude the presence of an occult recurrent laryngeal injury with a unilateral paralyzed vocal cord. Bilateral recurrent laryngeal nerve dysfunction will result in airway occlusion once the patient is extubated.

## Injury to the Structures in the Carotid Sheath

To avoid injury to the carotid artery, internal jugular vein, or vagus nerve, care must be taken not to enter the carotid sheath. Laceration of the carotid artery may result from the sharp teeth of retractor blades or during dissection with sharp instruments. In most cases, carotid artery lacerations can be repaired primarily. However, one may consider abandoning the procedure if such an injury occurs early in the course of the operation.

It is important to recognize that manipulation of the carotid artery may result in a stroke secondary to either mechanical compression of the artery or dislodgement of debris from a preexisting carotid plaque.[14] In some cases, it may be useful to monitor the temporal artery pulse after placement of the self-retaining retractors to avoid the risk of stroke as a result of carotid occlusion from retraction.

Injury to the internal jugular vein can result from either sharp dissection or the sharp teeth of a dislodged self-retaining retractor, usually causing a significant amount of bleeding and compromising the exposure of the other important anatomic structures. Bleeding should be controlled, and either the laceration should be repaired or the jugular vein should be ligated.

Injury to the vagus nerve can result from entry into the carotid sheath. This is an unusual complication, but if transection is observed intraoperatively, primary anastomosis should be attempted.

## Injury to the Vertebral Artery

Injury to the vertebral artery may result from asymmetrical and far lateral bone removal and is most likely to occur on the left side during a standard right-sided approach (Fig. 56-4). In a cadaveric study, the course of the vertebral artery was analyzed in 222 cervical spines. A 2.7% incidence of tortuous vertebral artery was identified.[15] Injury to the vertebral artery can also result from aggressive dissection of the longus colli muscles, which injures the vascular structures between the transverse processes.[16] Although primary repair of the vertebral arteries has been recommended, this is usually difficult. Commonly, bleeding can be controlled with gentle compression using a muscle pledget, Gelfoam, or oxidized cellulose (Surgicel), after which an angiogram should be obtained to rule out the development of an arteriovenous fistula or pseudoaneurysm.[17] To avoid this injury, one should identify the midline carefully and proceed with drilling accordingly.

Occasionally, transection of the vertebral artery can occur inadvertently during decompression of the vertebral artery via a ventrolateral approach. When this occurs, it requires control of the bleeding by a ligature at the level above and below the lesion. The risk of neurologic deficit after a unilateral vertebral artery occlusion is low.[16] Thorough mobilization of the vertebral artery invariably causes bleeding from the surrounding venous plexus; consequently, vigorous retraction and aggressive mobilization of the vertebral artery should be avoided to minimize hemorrhage.

## Injury to the Sympathetic Chain

The sympathetic chain may be more vulnerable to damage during ventral lower cervical spine procedures because it is situated closer to the medial border of the longus colli muscles at C6 than at C3. The longus colli muscles diverge laterally and the sympathetic chain converges medially at C6.[18] Injury to the cervical sympathetic chain, which results in Horner syndrome, is unusual but can result from either retraction or transection of the sympathetic chain. The incidence of permanent injury is less than 1%.[19] To avoid this injury during a ventral approach, the soft tissue dissection should be limited to the medial aspect of the longus colli muscles.

During a ventrolateral approach, the sympathetic chain is particularly at risk of injury. The sympathetic chain is located ventral to the transverse processes. It is either embedded in the dorsal carotid sheath or lies on the connective tissue between the sheath and the longus colli muscle. To avoid injury, the superior cervical ganglion at C1 and the middle cervical ganglion at C6 should be included with the sympathetic chain as it is retracted laterally to medially together with the longus colli muscle.

## Increased Neurologic Deficit

Increased neurologic deficit after a ventral cervical operation is unusual. Most spinal cord or nerve root injuries are associated with technical mishaps (excepting most C5 deficits).

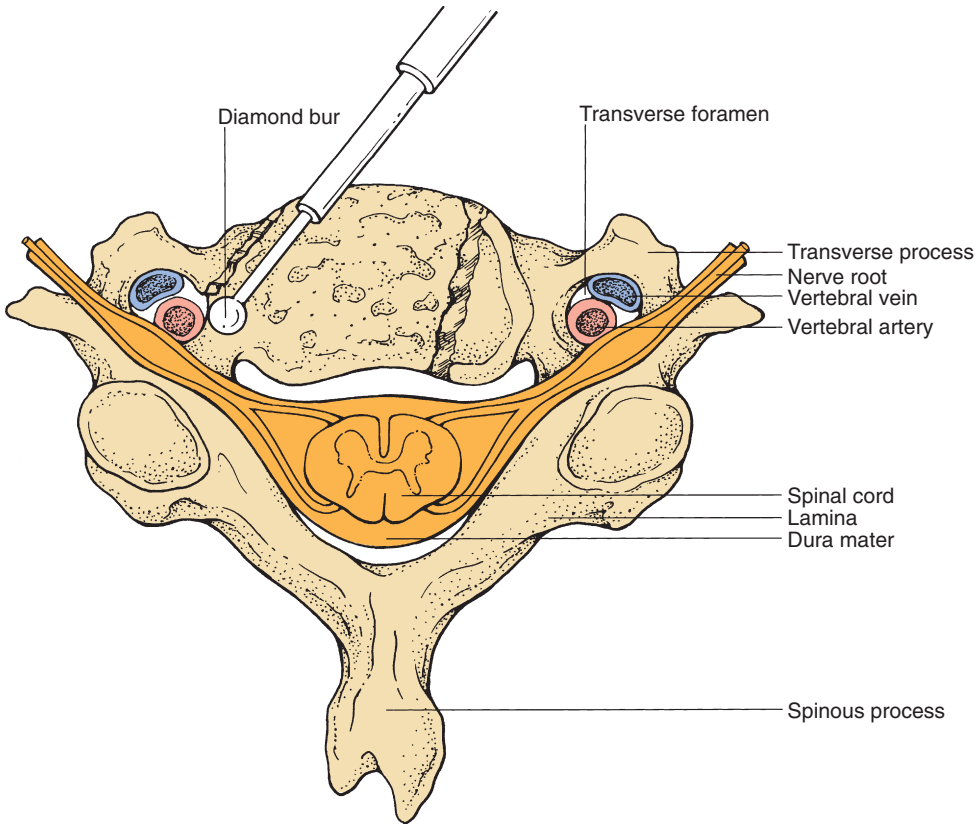


**Figure 56-4.** Mechanism of injury at the vertebral artery as a result of misassessment of the midline or asymmetrical drilling.

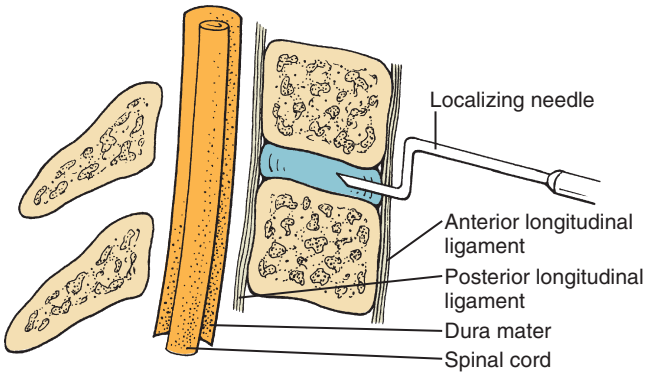


**Figure 56-5.** The localizing needle (18-gauge spinal needle) needs to be bent at the tip to prevent inadvertent penetration of the spinal cord.

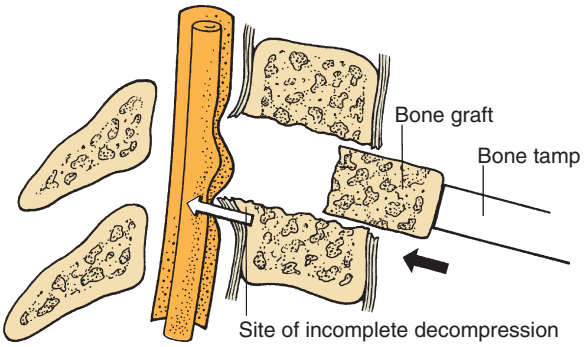


**Figure 56-7.** Possible mechanism of spinal cord injury in cases of incomplete decompression as a result of the "water hammer" effect during the placement of bone graft. Impaction of the bone graft may result in transmission of force vectors to the spinal cord via the persistent osteophyte.

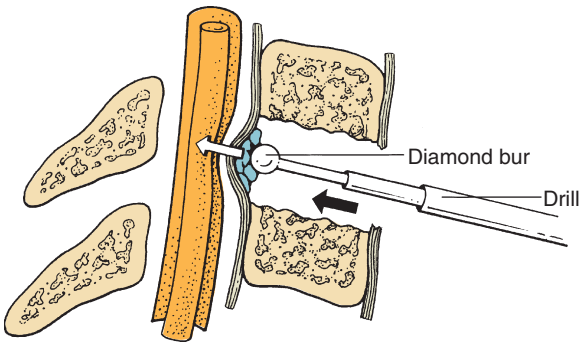


**Figure 56-6.** Possible mechanism of injury if the bone fragments become disconnected from the vertebral bodies before they have been completely thinned out during the removal of spondylotic ridges. In this case, the remaining mobile fragment may cause neural impingement during further drilling.

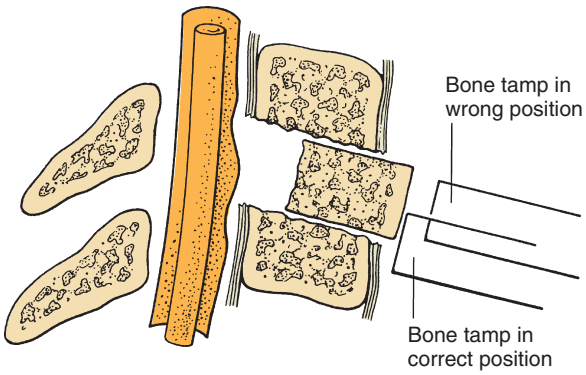


**Figure 56-8.** Recommended position of the bone tamp during the final positioning of the bone graft to prevent inadvertent advancement into the spinal cord. The tamp cannot pass beyond (dorsal) to the ventral margin of the vertebral body. The seating of the bone graft into a recessed position may require the angling of the tamp, while maintaining the obligatory positioning of the tamp partially over the vertebral body.

Although the exact figure is difficult to determine, Flynn[19] reported a 1.3% incidence of additional radicular dysfunction and a 3.3% incidence of worsening myelopathy.

To avoid neurologic injury, certain measures should be undertaken at every step of the procedure. Important precautionary measures regarding positioning, neck hyperextension, intubation, and electrophysiologic monitoring have been described. During intraoperative localization, the localizing needle (18-gauge spinal needle) in the disc space should be bent at the tip, as shown in Figure 56-5, so that inadvertent advancement of the needle into the spinal canal is not possible.

During the removal of spondylotic ridges, it is important that osteophytes not be disconnected from the vertebral bodies until they have been thinned sufficiently to permit removal with fine curettes. Otherwise, further attempts to drill may result in compression of the spinal cord (Fig. 56-6). Achieving a complete decompression before placement of the interbody graft is also crucial. As shown in Figure 56-7, in instances of incomplete decompression, tapping of the bone graft may result in compression of the spinal cord. During the final advancement of the graft, a bone tamp should be positioned in such a way that one half of the surface of the tamp is placed against the remaining rostral or caudal vertebral body (Fig. 56-8). This placement avoids an inadvertent advancement of the graft into the spinal canal and thereby prevents spinal cord compression. Countersinking of the graft can be accomplished by angling the tamp but maintaining the position of the tamp relative to the vertebral body (see Fig. 56-8). Occasionally, misplacement or displacement of a graft may cause nerve or cord compression. To avoid this injury, the depth of the graft should be measured carefully, and the depth of the vertebral body should be measured on preoperative imaging studies. If the depth of the interbody graft in an anteroposterior plane is limited to 13 mm, penetration of the spinal canal is unlikely. Nerve root injuries are less common than spinal cord injuries, but for unclear reasons, the C5 nerve root is sensitive to trauma.[20]

If a neurologic deficit is not present immediately after the patient awakens but appears within hours, the possibility of an epidural hematoma should be considered. In the case of suspected epidural hematoma with rapidly deteriorating neurologic function, the patient should be returned to the operating room for immediate exploration, without delay for diagnostic studies. In patients who have neurologic deficits immediately after surgery, one should consider administering glucocorticoids and should obtain lateral cervical spine radiographs to determine the position of the bone graft. If the patient's neurologic status is stable, magnetic resonance imaging (MRI) may be valuable to determine the cause of the deterioration. If a hematoma or bone graft misplacement is suspected, expeditious reexploration is required.

If neurologic worsening occurs within days after the operation, an epidural abscess must be considered in the differential

diagnosis. Obviously, the abscess should be drained as soon as possible, and the patient should be treated with appropriate antibiotics.

Sleep-induced apnea has been reported as an unusual complication of ventral cervical spine surgery. It is usually a self-limited process. Supportive respiratory therapy is occasionally needed.[21]

### Dural Laceration and Cerebrospinal Fluid Fistula

Dura mater laceration and cerebrospinal fluid leak may occur during removal of the posterior longitudinal ligament or during drilling. Direct repair is usually not feasible. A piece of Gelfoam should be placed over the dural defect, and lumbar subarachnoid drainage should be considered for 4 to 5 days. To minimize the chance of dural laceration from the drill bit, one should consider switching to a diamond drill when the dorsal cortex or the slope of the uncovertebral joints is encountered. The surgeon must also be aware that the nerve roots are more ventrally located than the spinal cord. Therefore, if one were to continue drilling laterally at the same ventrodorsal depth as the midline dura mater, violation of the dural sleeves of the nerve roots and, possibly, of the vertebral artery could occur.

## Postoperative Period

### Soft Tissue Hematomas and Respiratory Problems

Cervical soft tissue hematomas after ventral cervical operation are unusual, and many can be managed nonoperatively. However, a large hematoma may lead to airway obstruction and is a potentially life-threatening complication. To avoid this problem, careful hemostasis before closure is imperative. A Jackson-Pratt drain, inserted in the prevertebral space before closure, can be left in place for 24 hours in case adequate hemostasis was not achieved. The patient should be monitored carefully in the recovery room after the operative procedure for signs of respiratory insufficiency or cervical swelling. If a palpable hematoma is noted immediately after the cervical procedure but the patient does not have any respiratory compromise, the hematoma may be treated expectantly. However, a large or expanding hematoma should be drained, even if the patient is otherwise asymptomatic. If respiration is compromised, emergency treatment is required. The patient needs to be reintubated, if possible, and the wound opened. If intubation is not easily accomplished, the wound should be reopened in the recovery room and, if necessary, the airway reestablished via a tracheotomy or cricothyroidotomy.

### Postoperative Infection

Infectious processes can occur after a ventral cervical operation and can affect only the superficial layers or can involve the deeper structures. These are reported in 0.4% to 2% of patients with spine complications.[22] Superficial infections external to the platysma muscle can be treated by a simple opening of the incision, followed by dressing changes and the administration of appropriate antibiotics and secondary closure.

Cellulitis or abscess in the deeper tissues, however, requires a more thorough evaluation. Perforation of the esophagus or pharynx should always be considered a possibility and a potential source of infection. This is especially true when an unusual mixture of organisms is identified. In such instances, the incision should be explored under general anesthesia to drain the abscess and investigate the possibility of an esophageal perforation with intraoperative inspection. Subsequently, a postoperative esophagogram and CT scan should be obtained to assess the status of the perforation.

The issue of interbody graft removal in the presence of infection is complex. We choose to leave the graft in place, treat with antibiotics, and follow the status of the graft with cervical spine films. If the graft is collapsing, removal and replacement with autograft would be indicated; in most cases, bone healing will take place.

Epidural abscesses and meningitis have also been reported in association with ventral cervical operations. However, these complications are rare.[23] If a patient has progressive postoperative spinal cord dysfunction, with or without evidence of osteomyelitis or systemic signs of sepsis, epidural abscess should be considered in the differential diagnosis. MRI can be used to establish the diagnosis. Meningitis should be considered in a septic patient if a dural laceration was observed or suspected intraoperatively. Lumbar puncture may be required to confirm the suspicion.

### Graft-Related Complications

The predominant complications related to the bone graft are graft collapse, extrusion and migration, and nonunion. These may occur from suboptimal sizing, vertebral endplate fracture, postoperative trauma, or inadequate immobilization. Graft collapse is most frequently observed in elderly patients with osteoporotic bone. If there is any question regarding the structural integrity of autologous bone, an allograft may be used. However, in younger patients, autologous graft is stronger than allograft in resisting axial compression. The majority of patients with graft collapse are asymptomatic and do not require reoperation.

Graft extrusion and migration are reported in 2.1% to 4.6% of single-level fusions and in 10% to 29% of multilevel fusions with bony or ligamentous instability after ventral cervical discectomy and fusion. Graft displacement may require reoperation if the patient reports dysphagia, respiratory compromise, or neurologic deficits.[24,25] A well-fitting graft and placement under compression may help reduce this complication.

Graft pseudarthrosis has been reported in 5% to 10% of patients who undergo single-level fusion, in 15% to 20% of two-level fusions, and in 30% to 63% of three-level fusions.[24] Despite radiographic nonunion, the majority of these patients are clinically asymptomatic, and reoperation is not indicated. However, persistent neck pain, progressive angulation, and subluxation may mandate graft revision.

### Failure to Improve

The patient with nerve root compression should have immediate or nearly immediate relief of arm pain after the surgical procedure. There is a group of patients, however, who do not follow this pattern but who ultimately have a good result. Some patients may have arm discomfort persisting for several weeks. Usually immediate imaging studies are not required in such cases. However, if the pain is severe or increases during the period of observation, one should consider obtaining cervical spine radiographs to be certain that the surgical level is correct and the graft has been properly placed. If the symptoms persist for more than 2 to 3 months, the patient will likely require reevaluation using MRI or CT myelography.

The patient with persistent or worsened myelopathy presents a more difficult problem. Although most patients, after a satisfactory decompression, should have immediate improvement of some symptoms, overall improvement of myelopathic symptoms may take longer than recovery from radicular symptoms. If a patient does not have any significant neurologic recovery, imaging studies should be considered at some point to rule out the possibility of an inadequate decompression. In such instances, reoperation may then be considered.

## KEY REFERENCES

Ardon H, Van Calenbergh F, Van Raemdonck D, et al. Oesophageal perforation after anterior cervical surgery: management in four patients. *Acta Neurochir (Wien)*. 2009;151:297-302.

Bose B, Sestokas AK, Schwartz DM. Neurophysiological detection of iatrogenic C-5 nerve deficit during anterior cervical spinal surgery. *J Neurosurg Spine*. 2007;6:381-385.

Ebraheim NA, Lu J, Yang H, et al. Vulnerability of the sympathetic trunk during the anterior approach to the lower cervical spine. *Spine*. 2000;25:1603-1606.

Eskander MS, Connolly PJ, Eskander JP, et al. Injury of an aberrant vertebral artery during a routine corpectomy: a case report and literature review. *Spinal Cord*. 2009;47:773-775.

Kahraman S, Sirin S, Erdogan E, et al. Is dysphonia permanent or temporary after anterior cervical approach? *Eur Spine J*. 2007;16:2092-2095.

Miscusi M, Bellitti A, Peschillo S, et al. Does recurrent laryngeal nerve anatomy condition the choice of the side for approaching the anterior cervical spine? *J Neurosurg Sci*. 2007;51:61-64.

The complete list of references is available online at ExpertConsult.com.

## REFERENCES


1. Verbiest H. A lateral approach to the cervical spine: technique and indications. *J Neurosurg*. 1968;28:191-203.
2. Hodgson A. Approach to the cervical spine C3-C7. *Clin Orthop*. 1965;39:129-134.
3. Khan MH, Smith PN, Balzer JR, et al. Intraoperative somatosensory evoked potential monitoring during cervical spine corpectomy surgery: experience with 508 cases. *Spine (Phila Pa 1976)*. 2006;31:E105-E113.
4. Beutler WJ, Sweeney CA, Connolly PJ. Recurrent laryngeal nerve injury with anterior cervical spine surgery risk with laterality of surgical approach. *Spine*. 2001;26:1337-1342.
5. Winslow CP, Winslow TJ, Wax MK. Dysphonia and dysphagia following the anterior approach to the cervical spine. *Arch Otolaryngol Head Neck Surg*. 2001;127:51-55.
6. Ardon H, Van Calenbergh F, Van Raemdonck D, et al. Oesophageal perforation after anterior cervical surgery: management in four patients. *Acta Neurochir (Wien)*. 2009;151:297-302.
7. Dakwar E, Uribe JS, Padhya TA, et al. Management of delayed esophageal perforations after anterior cervical spinal surgery. *J Neurosurg Spine*. 2009;11:320-325.
8. Shenoy SN, Raja A. Delayed pharyngo-esophageal perforation: rare complication of anterior cervical spine surgery. *Neurol India*. 2003;51:534-536.
9. Melamed H, Harris MB, Awasthi D. Anatomic considerations of superior laryngeal nerve during anterior cervical spine procedures. *Spine (Phila Pa 1976)*. 2002;27:E83-E86.
10. Miscusi M, Bellitti A, Peschillo S, et al. Does recurrent laryngeal nerve anatomy condition the choice of the side for approaching the anterior cervical spine? *J Neurosurg Sci*. 2007;51:61-64.
11. Apfelbaum RI, Kriskovich MD, Haller JR. On the incidence, cause, and prevention of recurrent laryngeal nerve palsies during anterior cervical spine surgery. *Spine*. 2000;25:2906-2912.
12. Cannon RC. The anomaly of nonrecurrent laryngeal nerve: identification and management. *Otolaryngol Head Neck Surg*. 1999;120:769-771.
13. Kahraman S, Sirin S, Erdogan E, et al. Is dysphonia permanent or temporary after anterior cervical approach? *Eur Spine J*. 2007;16:2092-2095.
14. Yeh YC, Sun WZ, Lin CP, et al. Prolonged retraction on the normal common carotid artery induced lethal stroke after cervical spine surgery. *Spine (Phila Pa 1976)*. 2004;29:E431-E434.
15. Curylo LJ, Mason HC, Bohlman HH, et al. Tortuous course of the vertebral artery and anterior cervical decompression: a cadaveric and clinical case study. *Spine*. 2000;25:2860-2864.
16. Burke JP, Gerszten PC, Welch WC. Iatrogenic vertebral artery injury during anterior cervical spine surgery. *Spine J*. 2005;5:508-514.
17. Eskander MS, Connolly PJ, Eskander JP, et al. Injury of an aberrant vertebral artery during a routine corpectomy: a case report and literature review. *Spinal Cord*. 2009;47:773-775.
18. Ebraheim NA, Lu J, Yang H, et al. Vulnerability of the sympathetic trunk during the anterior approach to the lower cervical spine. *Spine*. 2000;25:1603-1606.
19. Flynn TB. Neurologic complications of anterior cervical interbody fusion. *Spine*. 1982;7:536-539.
20. Bose B, Sestokas AK, Schwartz DM. Neurophysiological detection of iatrogenic C-5 nerve deficit during anterior cervical spinal surgery. *J Neurosurg Spine*. 2007;6:381-385.
21. Krieger AJ, Rosomoff HL. Sleep-induced apnea. 2. Respiratory failure after anterior spinal surgery. *J Neurosurg*. 1974;40:181-185.
22. Salcman M. Complications of cervical spine surgery. *Crit Care Med*. 2001;29:2027-2028.
23. Bertalanffy H, Eggert HR. Complications of anterior cervical discectomy without fusion in 450 consecutive patients. *Acta Neurochir (Wien)*. 1989;99:41-50.
24. Parsons IM, Kang JD. Mechanisms of failure after anterior cervical disc surgery. *Curr Opin Orthop*. 1998;9:2-11.
25. Zaveri GR, Ford M. Cervical spondylosis: the role of anterior instrumentation after decompression and fusion. *J Spinal Disord*. 2001;14:10-16.