CE

1.5 ANCC Contact Hours

Surgical Complications Associated With Cervical Spine Surgery

Christopher Hemmer

Cervical spine complaints are routinely evaluated in the office and urgent care facilities. Many of these complaints will resolve with conservative modalities. However, when operative intervention is necessary for nontraumatic pathology, recognition of pre-, intra-, and postoperative complications is imperative. This article reviews basic anatomy and surgical anatomy of the cervical spine. The common surgical approaches to the cervical spine as well complications that can occur from an anterior and posterior perspective are discussed. Cervical spine surgery when used in the appropriate clinical scenarios can be very successful. It is important to remember that risk reduction begins prior to the surgery with appropriate planning, identification of any anatomical anomalies, and adequate preparation.

Epidemiology

Neck pain is a commonly reported pathology in the United States. It is suggested that up to 54% of the population will have some degree of neck pain over their lifetime (Cote, Cassidy, & Carroll, 2000). Cervical related complaints are more common in patients who tend to be well educated, report a history of headaches, and previous traumatic episodes such as whiplash (Todd, 2011). Gender seems to affect the incidence of neck pain as well. Females are 1.38 times more likely to have axial column neck pain when compared with their male counterparts (Raghavendra & Holtman, 2016). Although cervical degenerative complaints tend to be very common, true cervical radicular complaints tend to be much lower. Less than 2% of patients presenting with cervical related neck pain go on to require operative intervention. However, age-related degenerative changes seen in patients older than 30 years on radiographs and magnetic resonance images are ubiquitous (Mazanec & Reddy, 2007). Although anterior cervical discectomy and fusion is one of the most commonly performed spinal surgical procedures, there are inherent risks that include but are not limited to esophageal perforation, epidural hematoma, C5 nerve palsy, recurrent laryngeal nerve palsy, superior laryngeal nerve palsy, glossily pharyngeal nerve palsies, dural tear, brachial plexopathies, blindness, graft extrusion, hardware migration, infection, vascular injury, Horner's syndrome, thoracic duct injury, quadriplegia, and pseudomeningocele (Ghobrial et al., 2017).

Pathology

Cervical spine pathology can be categorized into axial column complaints, radiculopathy, and myelopathy. Axial column pain is generally described as pain in the neck, with minimal pain in the arms or shoulder blades. It is thought that this pain occurs from the overall degenerative nature of the disk, annular tears, and facet arthritis (see Figure 1). Radicular pain implies that the patient has pain that also extends to the upper extremities consistent with a dermatomal pattern (Todd, 2011). Many times this pain is unilateral and can be accompanied with muscle weakness specific to the dermatome or myotome pattern. A common example of radicular pain would be a herniated nucleus pulposus with compression of the exiting nerve. Myelopathy, which means sick or bad cord, implies that the spinal cord is so compressed that the patient may have difficulty with fine motor skills, ambulation, bowel control, bladder control, as well as various upper or lower extremity complaints, according to Dr. Terrence Piper, orthopaedic spine surgeon (personal communication, "Surgical complications with the cervical spine," February 16, 2018). Clinical cervical myelopathy is considered the most severe and urgent type of degenerative cervical pathologies.

Anatomy

The cervical spine comprises seven vertebral bodies. The C1–C2 articulation does not have an intervertebral disc and is considered to be very unique in relation to the remaining cervical vertebral bodies. The atlantoaxial junction (C1–C2) comprises a ring-like bone with a small spinous process, and the body contains two lateral masses that sit over the C2 vertebral body with an odontoid process also called a dens (see Figures 2 and 3). The remaining cervical vertebral bodies from C3 to C7 are similar from an anatomical perspective. Each of these vertebral bodies contain a spinous process that may be bifurcated, a transverse process with a foramen transversarium, a vertebral foramen, an uncinate process, superior and inferior articular facts, and the lamina (see Figures 3 and 4).

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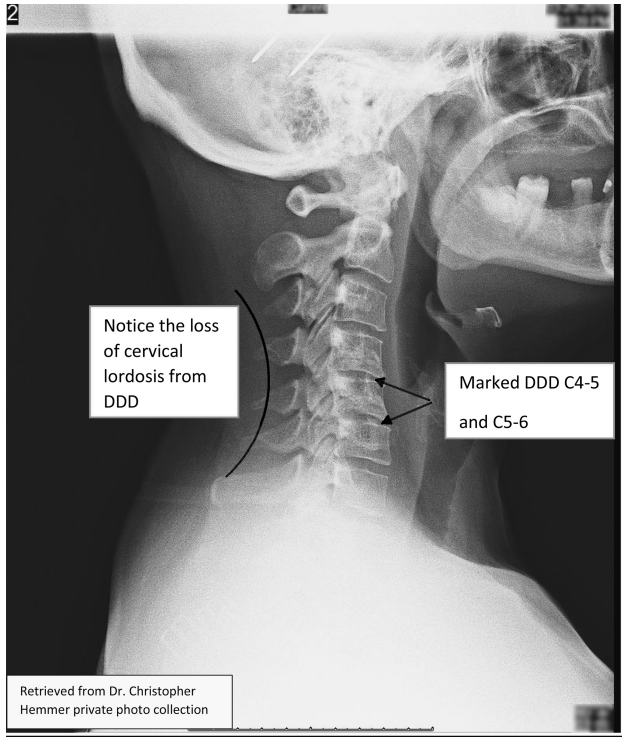

FIGURE 1. DDD cervical spine.

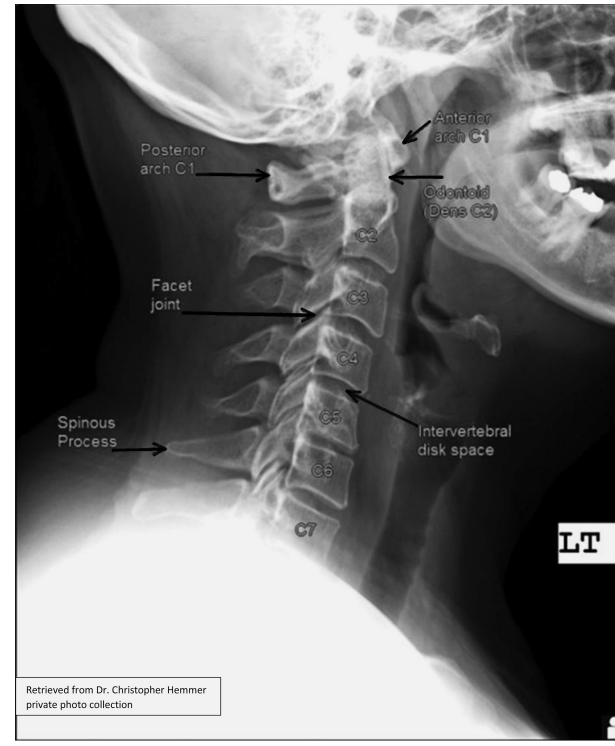

FIGURE 2. Normal anatomy of cervical spine x-ray.

The cervical spine is richly innervated with vascular structures including the vertebral artery coursing just lateral to the discogenic spaces (see Figure 5).

Common Complications With Anterior Cervical Approach

Surgical approach to the anterior cervical spine is a commonly utilized technique on patients with underlying degenerative disc disease, cervical radiculopathy, and cervical myelopathy. Anterior approach can also be utilized for more complex cases such as tumor resection and ossification of posterior longitudinal ligament or in cases where a posterior approach is not optimal such as existing kyphosis. Positioning of the patient is important to permit adequate exposure as well as to avoid any pressure areas that may lead to iatrogenic injury. Commonly, tape traction is utilized over the coracoid process to allow lateral imaging via fluoroscopy. Care should be taken to avoid excessive traction that can lead to compression of the brachial plexus and subsequent iatrogenic injury to the peripheral nerves. Another common area that can lead to neurogenic injury intraoperatively is compression over the fibular head due to compression of the peroneal nerve if the legs are placed in abduction and external rotation without appropriate padding (Cheung & Luk, 2016). Care should be taken by the operating room nurse to pad all bony prominences prior to the beginning of the case to avoid compression injury or skin breakdown intraoperatively.

A minor but frequent complaint met postoperatively with anterior cervical spine surgery is mild to moderate dysphagia due to mobilization of the trachea and esophagus during exposure as well as intubation. In milder cases, this can resolve in a week; however, with moderate or significant complaints, it can last as long as up to 4 weeks (Yadav, Chavali, Chaturvedi, & Rath, 2017). It is generally accepted that the more levels addressed intraoperatively, the greater the risk and significance of the

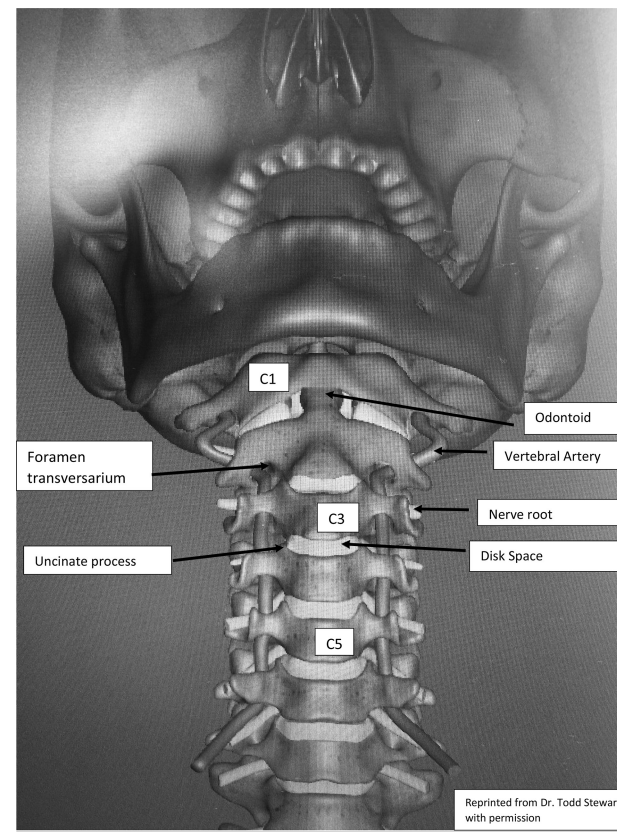

FIGURE 3. Animated anatomy of cervical spine.

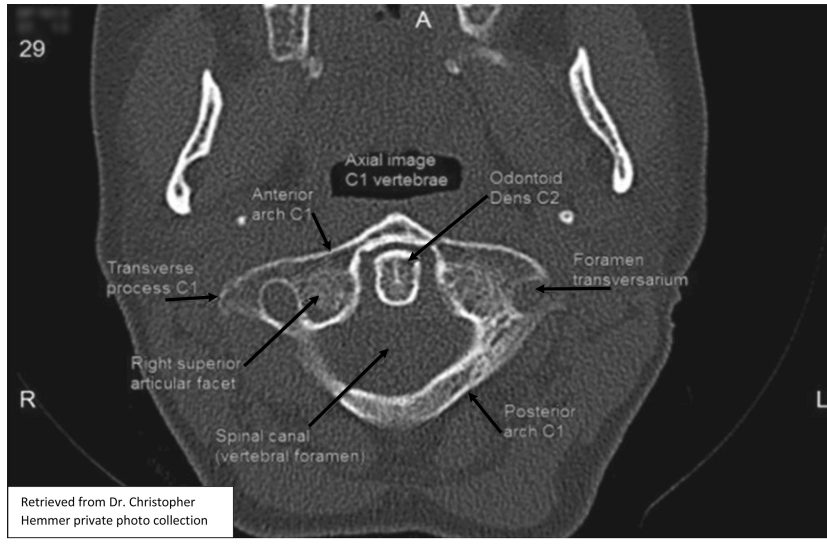

Figure 4. Axial CT of C1-2.

dysphagia noted because of prolonged retraction time and intubation (Gokaslan et al., 2017). During recuperation, soft foods should be encouraged. The postoperative nurse should also be cognizant for signs of aspiration or swallowing difficulties in the early postoperative period.

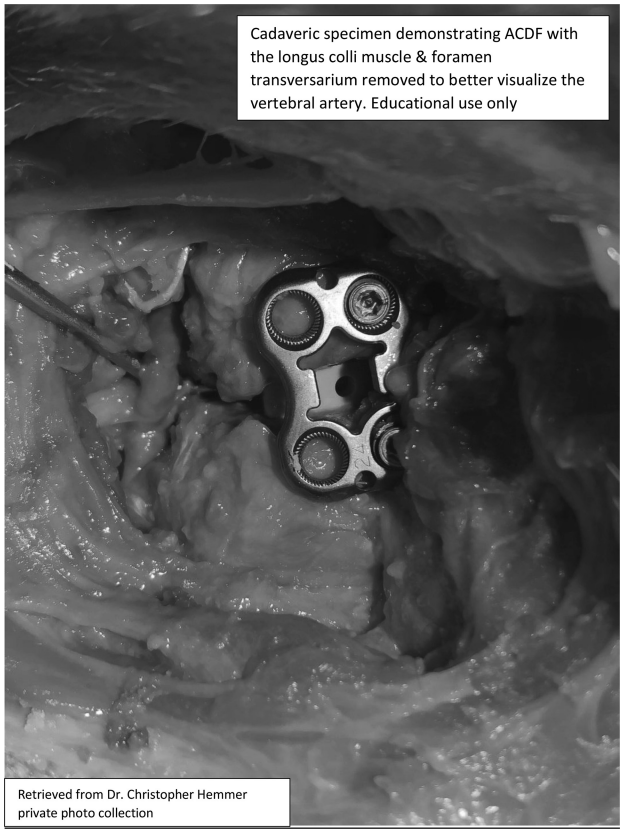

Figure 5. Cadaveric specimen demonstrating anterior cervical discectomy and fusion, with the longus colli muscle and foramen transversarium removed to better visualize the vertebral artery.

Along with dysphasia, a somewhat more concerning finding would be postoperative dysphonia. Injury or excessive pressure on the recurrent laryngeal nerve, superior laryngeal nerve, or hypoglossal nerves can lead to vocal cord paralysis, which occurs in less than 1% of cases (Cheung & Luk, 2016). There is much debate in the literature as to which side is safer to approach with anterior surgery. Most do agree that if revision surgery is necessary, approaching from the opposite side of previous surgery is optimal to avoid iatrogenic injury from exploring through a scarred surgical field. It is paramount that direct laryngoscopy to evaluate vocal cord function is completed prior to surgery to avoid further laryngeal nerve injury and the potential of bilateral vocal cord paralysis. The endotracheal tube accounts for this troubling finding in an estimated 11% of cases due to impingement on the tracheal wall that can compress portions of the recurrent laryngeal nerve as it supplies the vocal cords (Gokaslan et al., 2017). It has been suggested that in a long surgery where multiple levels are addressed, the endotracheal tube cuff be deflated for a short period of time to decrease the amount of pressure applied to this nerve structure (Cheung & Luk, 2016).

A very common late postoperative complication for anterior cervical discectomy and fusion is pseudarthrosis. Pseudarthrosis rates are based on multiple factors such as age, number of levels completed, comorbidity issues, and technique. Furthermore, some studies have shown that patients with a pseudarthrosis are asymptomatic in as many as 30% of the cases discovered (Leven& Cho, 2016). Smoking is associated with higher rates of pseudarthrosis, followed by obesity, poorly controlled diabetes, chronic steroid use, autoimmune medications, osteoporosis, malnutrition, and vascular abnormalities (Phillips, Carlson, Emery, & Bohlman, 1997). The advent and utilization of plate fixation have improved fusion rates for one-, two-, and three-level anterior cervical discectomies and fusion. Plate fixation has become widely accepted in both anterior cervical discectomy fusions and anterior corpectomy procedures. Evaluation postoperatively for a patient with suspected pseudarthrosis includes lateral

flexion–extension cervical spine radiography. Motion exceeding 2 mm between the spinous processes in flexion–extension views is suggestive of incomplete fusion. Thin cut computed tomography (CT) without contrast is also another appropriate tool to evaluate for good bony bridging across the operative level. Magnetic resonance imaging has been shown to be inferior to CT when evaluating and diagnosing pseudarthrosis in the patient with a previous anterior cervical discectomy and fusion (Leven & Cho, 2016).

Although infection in spine surgery is always of concern, the incidence of postoperative infection after anterior cervical discectomy and fusion is exceedingly uncommon. Reports of postoperative infection in the anterior cervical spine range from 0.05% to 1.6% (Ghobrial et al., 2017). The extremely rare nature of this complication makes it difficult to identify statistically significant risk factors for infection. Postoperative anterior infections do have a higher risk of concern due to the anatomical location and the potential for airway compromise. Patients may or may not present with the classic findings such as fever, surgical site pain, or neurological deficit. Persistent leukocytosis as well as elevated C-reactive protein after the first several days postoperatively should be very suspicious for infection. Should infection be identified in the immediate postoperative course, several factors should be considered. Airway management, injury to the esophagus, evaluation for epidural hematoma, and osteomyelitis/discitis should all be addressed in a very expeditious fashion (Ghobrial et al., 2017).

Less Common Complications With Anterior Cervical Fusion

A much less common complication postoperatively is retropharyngeal hematoma. The occurrence of postoperative hematoma in the retropharyngeal space is an infrequent complication of anterior cervical spine surgery but can result in airway compromise quite quickly (O'Neill, Neuman, Peters, & Riew, 2014). Typically, retropharyngeal hematomas will develop within 12–48 hours postoperatively but must be recognized to avoid catastrophic complication. Patients may present with complaints of inability to swallow or keep their own saliva down. Prompt evaluation with CT and clinical suspicion can reduce the need for emergent tracheotomy. Identification of this postoperative complication requires emergent operative decompression of the hematoma and cessation of its cause. Risk factors for retropharyngeal hematoma include the presence of diffuse idiopathic skeletal hyperostosis, presence of ossification of posterior longitudinal ligament, pharmacological anticoagulation and thrombolytics, operative time exceeding 5 hours, exposure of three or more vertebral bodies, or blood loss greater than 300 ml (O'Neill et al., 2014).

Injuries to vascular structures can be catastrophic during anterior cervical spine surgery. Specifically, the vertebral and carotid arteries are most susceptible during this type of approach. The clinical sequelae of an iatrogenic vertebral artery injury can vary widely depending on anatomical variation and the presence of collateral blood flow. Patients may have minimal but noticeable sequelae as well as more serious complications postoperatively including quadriparesis and mortality. Although most patients have normal vascular anatomy, it has been suggested that up to 5.4% of patients have anomalous course of the vertebral artery most of which occur around C1–C2 (Schroeder & Hsu, 2013). The farther lateral the exposure and decompression, specifically past the uncovertebral joints, the greater the risk of vascular insult (see Figures 3 and 5). Although the transverse foramen is most often located lateral to the uncovertebral joint, there is a 2.7% risk of a torturous or anomalous vertebral artery. In these cases, the foramen will actually be medial to the uncovertebral joint and would increase the risk of a vascular injury (Burke, Gerszten, & Welch, 2005).

When working in the anterior neck, another less common complication occurs to the sympathetic chain. The cervical sympathetic chain is found between the carotid sheath and the longus colli, which is commonly mobilized during mid-cervical approaches. Aggressive retraction or dissection lateral to the longus colli can cause injury to this structure (Cheung & Luk, 2016). Cervical sympathetic chain injury can result in Horner's syndrome, which is classically identified with myosis, ptosis, and anhidrosis. The incidence of such occurrence is found in approximately 4.2% of the patients undergoing anterior cervical discectomy and fusion.

An extremely rare complication due to anterior cervical discectomy and fusion is an iatrogenic injury to the esophageal oropharyngeal region. This can be caused by intubation or direct surgical trauma intraoperatively. The exact incidence of this uncommon complication is relatively unknown. Presentation may include sudden bouts of coughing with hemoptysis, subcutaneous emphysema, and unexplained fevers. When suspicion arises for this type of diagnosis, noncontrasted CT of the cervical spine with ingestion of oral contrast is most helpful to evaluate for occult tears or leakage (Yadav et al., 2017).

Common Complications With Posterior Cervical Spine Approaches

Overwhelmingly, the majority of cervical spine surgery is approached anteriorly. However, there are times when a posterior approach is more beneficial for a patient. For example, if there is a far lateral herniated disc in the cervical spine, the patient may benefit from a keyhole foraminotomy and discectomy as opposed to a fusion. Other common reasons to approach from a posterior perspective are to reinforce multilevel anterior cervical surgery such as a corpectomy, tumor, multilevel central canal stenosis, or unstable traumatic injury (see Figures 6 and 7). The posterior approach for treatment of multilevel severe central canal stenosis, which is commonly found in ossification of the posterior longitudinal ligament, is another common reason to approach the cervical spine from a posterior aspect. Finally, a posterior surgical approach is commonly used if the patient has been diagnosed with a pseudarthrosis from a previous anterior surgery; a posterior instrumented fusion may be the treatment of choice.

FIGURE 6. Anterior posterior fusion cervical spine.

FIGURE 7. Intraoperative decompression and fusion cervical spine.

Pseudarthrosis rates are much lower following posterior procedures than after anterior procedures alone (Fernyhough, White, & LaRocca, 1991). Although pseudarthrosis rates are typically lower with posterior procedures, historically patients who have had posterior arthrodesis are as much as seven times more likely to require reoperation due to adjacent segment disease than those undergoing posterior decompression alone and as high as three times more likely than those who have undergone anterior cervical discectomy and fusion (Leven & Cho, 2016). Furthermore, there is a longer recuperation period, increased blood loss, and increased postoperative wound complications with a posterior approach as opposed to an anterior approach alone.

Posterior cervical spine surgery brings an increased level of complication with screw fixation. Although it is true that the anterior approach poses the most risk for arterial injury, a posterior approach from C3 to the occiput is the most common area for vertebral artery injury to occur in posterior surgery. Many times these injuries occur because of the substantial vascular and skeletal variations in the high cervical spine (Hsu et al., 2017). When viewing from an axial perspective, a trajectory of 20°–30° lateral to midline is necessary to avoid injuring the vertebral artery. Subaxial lateral screws, below C1–C2, increase the risk of nerve root injury by 1.3%. When lateral mass screws are placed less than 15° in the sagittal plane, this can increase the risk of injury to the exiting nerve root with protruding screw threads.

Neurological injuries are also a concern whether the approach is anterior or posterior. When approaching the cervical spine from a posterior perspective, the C5 nerve root is of specific concern. The rationale is that C4–C5 is the apex of the cervical lordosis and the C5 nerve root is on a direct and short course as it exits from the spinal cord. It has been suggested that if posterior operative intervention in this region is necessary, a prophylactic keyhole foraminotomy be performed to decrease the risk of a postoperative C5 nerve root palsy (Cheung & Luk, 2016). C5 nerve palsies are likely to be seen immediately after surgery, affecting primarily the deltoid but can be noted as far out as 3 weeks postoperatively. Recuperation can take several weeks if not months and in some cases complete recovery never occurs. It has been suggested that the use of neuromonitoring can help decrease the risk of injury to the exiting nerves.

Before entertaining a posterior approach with any patient, the overall sagittal balance of the patient should be evaluated. Patients with loss of cervical lordosis or neutral lordosis will have an increased risk for postoperative kyphosis. Post-laminectomy kyphosis is of significant concern, especially in younger patients. However, older patients who have extensive arthritis may have some degree of autofusion taking place, decreasing the risk for iatrogenic postoperative kyphosis. In younger patients, when a laminectomy is proposed, careful thought should be given to fusion, especially in cases where the posterior facet joints are being disrupted or partially removed (Cheung & Luk, 2016).

Table 1. Complications of Anterior vs Posterior Cervical Surgery

Complication	Anterior Approach	Posterior Approach
Dysphagia/dysphonia	More common	Less common
Pseudarthrosis	Slightly more common	Uncommon
Risk of infection	Very uncommon	Slightly more common
Postoperative hematoma	Very uncommon	Slightly more common
Vascular injury	Very uncommon	Uncommon
Neurological injury	Very uncommon	Slightly more common
Postoperative pain	Generally mild/moderate	Generally moderate to moderate-severe
Adjacent segment disease	Slightly common	More common

Bone Graft Harvesting

Harvesting of iliac crest can take place regardless of whether an anterior or posterior surgical procedure will be performed. One of the main complaints with autograft is the long-term harvest site discomfort, especially over the iliac crest, which can last anywhere from just a few months up to several years (Leven & Cho, 2016). Anterior harvesting can yield injury to the lateral femoral cutaneous nerve or the ilioinguinal nerves due to retraction, compression, or subfascial hematoma. Posterior harvesting can lead to irritation to the superior cluneal nerve as it crosses lateral to the posterior iliac spine, which can lead to a paresthesia over the superior two thirds of the buttock. Bone harvesting, regardless of posterior or anterior approach, can cause neurogenic irritation, which can leave the patient with long-term paresthesia. These areas tend to be rather bloody and can increase the risk for postoperative hematoma, seroma, and possible infection. Watertight closure of these wounds is important to prevent seroma formation. It is important that these areas have adequate hemostasis prior to their closure utilizing bone wax in many cases (Cheung & Luk, 2016).

Nursing Implications

Nurses caring for patients perioperatively and in the weeks following surgery should familiarize themselves with the surgical approach utilized, the length of the surgery, intraoperative monitoring findings, and signs and symptoms of complications. Nurses present during the operative procedure should be cognizant of optimal patient positioning to alleviate or minimize compression of vital neurological structures and prevent intraoperative injury. Recognition of neuropathy, dysphagia, dysphasia, dysphonia, infection, and hematomas is imperative to prevent negative outcomes and should be assessed during postoperative monitoring and in return patient visits in the specialty outpatient office setting.

Conclusion

Anterior cervical surgery overall is considered to be a very successful option for many patients. Attention to details such as patient positioning, avoiding forceful manipulation of tissues, and identification of critical anatomical landmarks can prevent catastrophic events. Posterior cervical surgery, although not quite as common as anterior cervical surgery, has its own risk and benefits as discussed (see Table 1). Careful selection of patients to avoid injury to the C5 nerve root as well as iatrogenic kyphosis should be considered.

Any surgical procedure has associated risks. Cervical spine surgery when used in the appropriate clinical scenarios can be very successful. It is important to remember that risk reduction begins prior to the surgery with appropriate planning, identification of any anatomical anomalies, and adequate preparation. It is also becoming widely accepted to use neuromonitoring in the cervical spine to decrease the risk of intraoperative neurological injury. When carefully and properly executed, cervical spine surgery can be an effective option with very acceptable rates of complication (Cheung & Luk, 2016).

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