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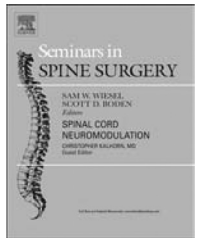

Cervical spine surgery: Complications and considerations

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A B S T R A C T

Surgery is a successful treatment option for traumatic or degenerative mechanical pathologies of the cervical spine. These surgeries can be performed from either an anterior or posterior approach. Each approach has its own indications and associated potential complication profile. The anterior approach is the work horse of degenerative spinal pathologies but is associated with unique proximity related visceral complications like dysphagia, dysphonia, esophageal or oropharyngeal injury, and sympathetic chain injuries. The posterior approach to the cervical spine has fewer indications relative to the anterior approach but again has its own unique complication profile including C5 palsies and epidural hematomas.

1. Introduction

Complaints of neck pain are frequently encountered in the clinical setting. It is estimated that over half of the general population will encounter symptomatic cervical pathologies over the course of their lifetime.[1] Fortunately, for most patients this axial column pain is primarily self-limited and resolves with conservative therapy due to the inflammatory nature of their underlying pathology.[2] However, for the patients who have radicular or myelopathic symptoms that have failed or are not amenable to conservative therapy, cervical spine surgery is often required.[3]

Cervical spine surgery is an extremely safe and effective way at combatting certain identifiable mechanical spine pathologies. As with any surgical intervention, these procedures come with inherent risks and benefits. Therefore, discussions surrounding the weight of each of these potential outcomes must always be had at length. With that being said, when appropriate preoperative attention is paid to both a patient's medical and anatomical variances, adverse events associated with these procedures can be minimized.[3] Nonetheless, even with appropriate preoperative planning and intraoperative technique, complications due occur due to the very nature of these invasive procedures.[2–5] The complications associated cervical spine surgery can range from life altering ailments like spinal cord injury to self-limiting pathologies like dysphagia, tend to occur at much different frequencies based on whether an anterior or posterior approach was used to gain access to the underlying pathology due to the associated anatomical structures.[4,5]

The cervical vertebral column can be accessed through a variety of both anterior and posterior dissections. The primary modality by which cervical spine surgery is performed today is via an anterior approach, but there are certain pathologies for which a posterior approach is indicated.[2] Therefore, understanding the associated anatomical considerations of both approaches is paramount to being a successful surgeon. With regards to the anterior approach, the major anatomical structures associated with potential adverse events are the vertebral and, to a lesser extent, carotid arteries, the recurrent laryngeal, superior laryngeal, and hypoglossal nerves, the sympathetic chain, the trachea, esophagus, and oropharynx, and lastly, the vertebral body itself, with

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particular attention being paid to the uncinate processes. With regards to posterior anatomic considerations, having a good appreciation of an individual's cervical lordosis and 3-dimensional vertebral anatomy is paramount, as screw positioning and spinal cord migration are major concerns during procedures done from this perspective.[2, 6–10]

2. The anterior approach

The primary surgical approach used for cervical spine surgery.[2] This dissection can be employed for addressing degenerative intervertebral disc disease, cervical radiculopathy, and cervical myelopathy. This approach can be carried out from either side of midline in primary procedures. Revision procedure should be done, if possible, from the contralateral side of the index procedure to avoid dissections through any anatomically distorting or concealing scar tissue.[2]

2.1. *Dysphagia*

One of the most common complications following anterior cervical spine surgery.[3] Although its true incidence is largely unknown due to a lack any standardized and universally accepted postoperative assessment tool, this complication occurs relatively frequently and almost entirely resolves within a few weeks of surgery.[3,11,12] A 2011 prospective trial examining this issue demonstrated that there was a 71% incidence of dysphagia at 2 weeks but that at 12 weeks, the incidence decreased to only 8%.[13,55] The underlying pathology associated with this disease process is a combination of laryngeal nerve irritation and pharyngeal edema causing some degree of associated epiglottic inversion while swallowing.[11] The mechanical nature of tracheal and esophageal retraction, along with associated intubation, has largely been hypothesized as the underlying cause of this adverse event.[2,3,11,12] Therefore, risk factors associated with this complication are primarily associated with issues that prolong surgery and therefore require a prolonged intubation and retraction time, which include multiple level procedures, obesity, revisions, and high cervical procedures.[13] The primary concern with regards to this complication, and is something the entire perioperative team should be aware of, is aspiration, as 50% of patients who experience a difficulty swallowing will aspirate, so it is recommended that a diet consistent with a patient mechanical deficiencies be employed.[2,3,11]

2.2. *Dysphonia*

Among one of the more frequent adverse events associated anterior cervical spine surgery, occurring in about 1% of all cases, this postoperative complication is primarily attributable to neuropraxia of the laryngeal nerves, recurrent or superior, or less frequently, the hypoglossal nerve during dissection.[14] While admittedly a less frequent cause of dysphonia relative to direct irritation, compression of the recurrent laryngeal nerve via the trachea due to the endotracheal tube has also been described, and is the reason that in prolonged surgery, it is recommended that cuff pressure holidays be employed throughout the case.[14,15] While this adverse event most frequently occurs immediately following surgery and is generally self-limited, symptom persistence should prompt laryngoscopic evaluation, especially if a revision procedure is required.[2] As vocal cord assessment may help direct ones surgical approach such that there is minimal risk for bilateral vocal cord paralysis if a preexisting deficiency exists. There have been case reports of delayed onset dysphonia, but the underlying etiology of this presentation is not fully understood and all reported events were self-limited.[16]

2.3. *Pseudoarthrosis*

This late complication of cervical spine fusion surgery can be diagnosed using lateral flexion and extension X-rays of the cervical spine or a fine cut CT scan of the involved vertebrae.[17] The diagnosis of this adverse event is much more common following anterior procedures relative to posterior procedures, but with the advent of anterior plate fixation, they have even become uncommon following those procedures.[2] While this adverse event is symptomatic in the majority of patients who have radiographically identified disease, over 25% of patients in this cohort with identified pathology are asymptomatic, which only underscores the complexity associated with cause and effect in cervical spine pathology.[17] Risk factors that have been identified amongst patients who present with this pathology are associated with patient comorbidities like increasing age, smoking status, uncontrolled diabetes, chronic steroid use, osteoporosis, and malnutrition, surgeon technique, and the number of levels involved in the procedure.[18] In symptomatic patients who are good operative candidates, the treatment of choice for many of these patients is construct stabilization, most often via a posterior fusion.[2]

2.4. *Anterior graft subsidence*

Anterior graft subsidence is a relatively common issue among patients who receive anterior cervical spine fusion surgery.[19] Patients who are most at risk for this radiographic finding are most commonly those who did not receive a tricortical bone graft and/or anterior plate fixation at the time of their index procedure.[20,21] The impact of this adverse radiographic finding has not been shown to correlate with fusion rates or overall adverse clinical outcomes.[19–21] With that being said, there is undoubtedly a subgroup of patients where recurrent foraminal stenosis is at least partially due to graft subsidence induced loss of vertebral disc space[3] [Fig. 1.].

2.5. *Infection*

A rare complication of cervical spine surgery with a reported incidence between 1.3 and 4.6%.[22–24] These complications most commonly present for evaluation 1 to 2 weeks postoperatively and require immediate surgical and medical intervention.[3] With the advent of modern peri and intra operative techniques like perioperative intravenous antibiotics and intrawound vancomycin powder, this incidence has decreased dramatically.[3,25] Due to the rarity of these complications, identifiable risk factors are not well described but prompt laboratory and radiographic evaluation should be exercised in all patients presenting with signs and symptoms concerning for infection. Rates of infection and associated

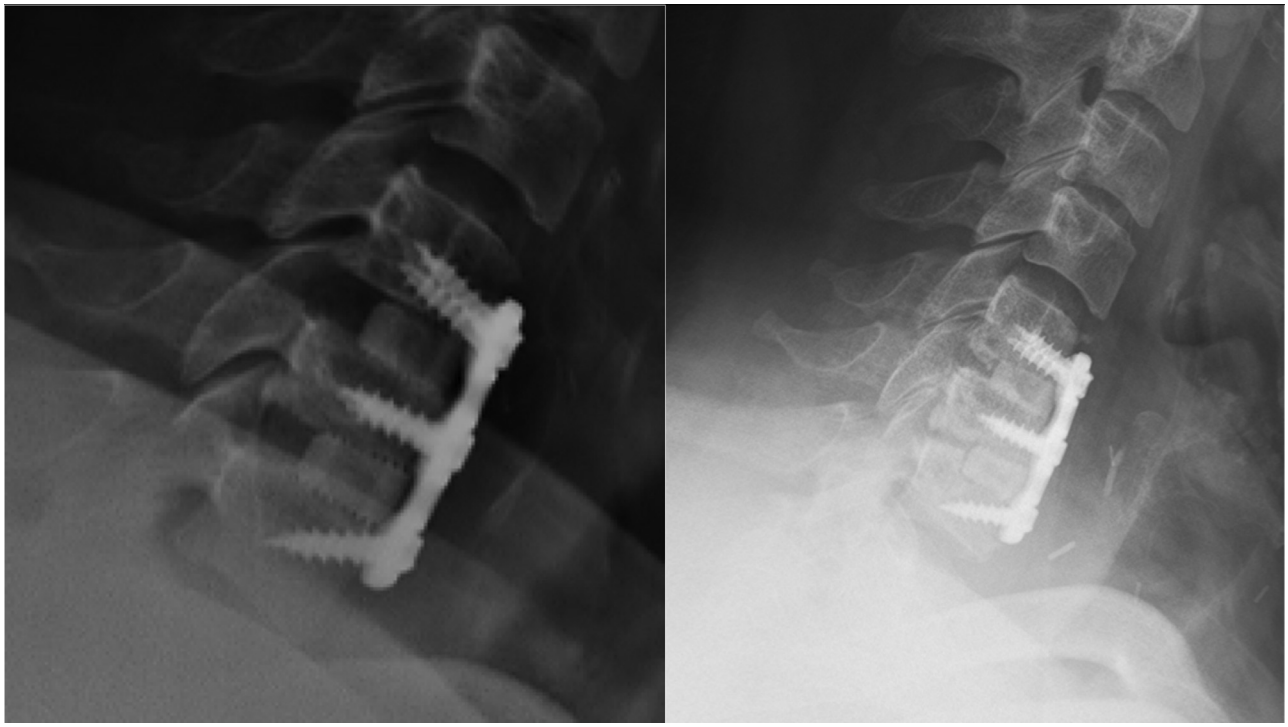

Fig. 1 – Anterior graft subsidence.

wound complications are much higher with posterior approaches to the cervical spine [Fig. 2.].

2.6. *Vascular injury*

A potentially devastating but rare complication associated cervical spine surgery with an overall incidence of less than 1%.[13,14] Although it is unknown what percentage of the vascular injuries associated with cervical spine surgery occurs in the presence of an anomalous vertebral artery, studies have demonstrated that up to 5.4% of the general population has at least one vertebral artery with an irregular course.[28,29] While this is undoubtedly a small proportion of our surgical population, the potentially devastating outcomes associated with failing to recognize these anomalies underscores the importance of not only intraoperative technique and diligence, but also complete preoperative radiographic assessment and planning.[30] While the long term sequelae of these intraoperative adverse events varies significantly based on the size and location of the injury, along with the presence of any collateral circulation, the post injury strategy for addressing them should extremely thorough and include both intraoperative tamponade and primary repair, along with postoperative endovascular evaluation, as delayed complications may occur in up to 50% of cases.[26,27] While prior cervical spine surgery and preexisting vascular disease increase ones risk for a vascular injury during cervical spine surgery, anomalous arterial anatomy is still the greatest risk factor for these adverse events.[27] Therefore, procedures like the anterior corpectomy, due to vicinity variances between the uncinate process and vertebral artery, and high cervical posterior instrumentation pose the greatest risk for vascular injury.[27,31]

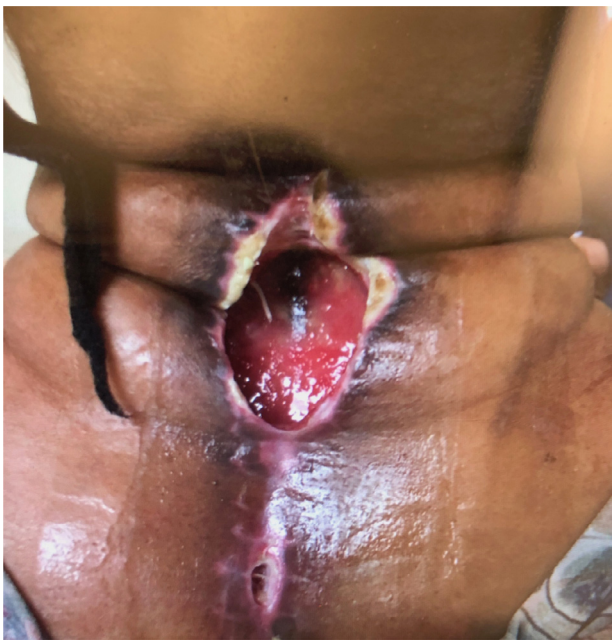

Fig. 2 – Posterior cervical wound dehiscence and infection.

2.7. *Esophageal or oropharyngeal injury*

A potentially fatal and devastating complication associated with anterior cervical spine surgery that most commonly occurs in the immediate intraoperative setting, but may present up to years later as a result of esophageal erosion from

anterior cervical plate fixation.[32,33,36] These adverse events have an incidence of less than 0.5% and are often due to modifiable surgical technique errors associated with aberrant retractor placement, most commonly over, instead of under, the longus colli muscle, resulting in inadequate esophageal protection or simply direct retractor trauma.[3,34–40] While many of these complications are recognized intraoperatively and are therefore repaired immediately via a surgical otolaryngologist or thoracic surgeon in an attempt to minimize the risk of postoperative infection, there are some that present in the postoperative setting.[41,42] Diagnosing these complications days, weeks, and even years following surgery often occurs in the setting of dysphagia, dyspnea, and irregular swelling with associated crepitus and require a high level of suspicion.[32–37] The diagnostic workup generally involves lateral cervical x-rays looking for subcutaneous air and referral to a specialist for laryngoscopy and potentially a CT scan of the cervical spine with oral contrast.[12,36,40]

2.8. Retropharyngeal hematoma

These complications, albeit relatively rare, must always be on the differential for any patient with dysphagia or dyspnea in the postoperative setting following anterior cervical spine surgery, especially those who are between 12 and 48 h postoperatively, as these complications are potentially fatal and are able to progress rapidly.[43] In any case, if your clinical suspicion is high enough and your patient is clinically stable, a STAT CT of the cervical spine may mitigate the need for an emergent tracheotomy and allow for a more urgent and safe hematoma evacuation.[2] With that being said, prevention is the best treatment any disease and therefore diligent intraoperative hemostasis at the index procedure is imperative for preventing these complications. Nonetheless, even with in situations where hemostasis is seemingly achieved without issue, these complications can still develop due to certain risk factors. Patients who are specifically at high risk are those patients who have recently taken any form of pharmaceutical anticoagulation, those patients with diffuse idiopathic skeletal hypertosis or ossification of their posterior longitudinal ligament, and lastly, those patients who had a procedure where they lost greater than 300 cc of blood or that lasted greater than 5 h.[44]

2.9. Sympathetic chain injuries

Horner's syndrome, which is characterized by ptosis, miosis, and anhidrosis, is relatively rare complication associated with anterior cervical spine surgery. The sympathetic chain lies between the carotid sheath and associated longus colli, which is therefore subject to irritation or injury most commonly during a midcervical dissection when the longus colli is retracted laterally.[14] While the full spectrum of symptoms of this pathologic process is quite rare, the incidence any sympathetic chain neurpraxia following anterior cervical spine surgery is approximately 4.2%.[2]

3. The posterior approach

Although the anterior approach is much more common, relative to the posterior approach, for addressing most cervical spine pathology, there are several disease processes that are either more amenable to a posterior approach, or require both an anterior and posterior approach for the most optimal outcome.[2] While the posterior approach to the cervical spine does provide superior outcomes for certain pathologies like a far lateral disc herniation induced cervical radiculopathy, in general this approach is associated with more blood loss, greater wound complication rates, and a longer postoperative recuperation relative to the anterior approach.[2]

3.1. C5 palsy

While true spinal cord injuries are an extremely rare complication associated with cervical spine surgery, nerve root irritation or damage occurs much more frequently.[45] Anatomically, most patients have a cervical lordosis with an apex between C4 and C5, which means that at that level, the potential for posterior spinal cord migration following decompression is the greatest.[14] While spinal cord migration is not by itself associated with any symptomology, the tension that posterior migration of the spinal cord applies to the, intrinsically short, ventrally exiting nerve roots, specifically C5 at this level, is often significant enough to induce acute onset weakness in a patients deltoid muscles.[2,45–47] Although identification and evaluation of this pathology is vital and requires prompt radiographic assessment to rule out any reversible etiologies, most patients, through aggressive physical therapy will regain most if not all of their strength.[2] Patients at greatest risk for developing this adverse event are those patients with excessive cervical lordosis or a circumferentially large spinal cord.[10,14] Strategies aimed at preventing this outcome in patients who undoubtedly require surgical intervention involve prophylactic keyhole foraminotomies, minimization of the width of the posterior laminectomy trough, and neuromonitoring.[2,10,14]

3.2. Epidural hematoma

Although this potentially paralysis-inducing complication only has an incidence between 0.1% and 3%, its prompt recognition and treatment is vital for preventing or reversing any neurologic deficits.[48,49] Risk factors for the development of these complications include any pharmaceutical anticoagulation, including NSAIDs, which increase ones risk by 6.6X, and a given patient's comorbidities, as a single point in Charlson Comorbidity Index increases ones risk by 1.6X.[49]

3.3. Adjacent segment disease

Although this postoperative complication occurs in both anterior and posterior cervical spinal fusion procedures, it is 3X more likely to occur if the fusion is done from an anterior approach.[50–54] Estimates from Hilibrand et al. suggest that this postoperative issue will be symptomatic in over 25% of patients receiving anterior cervical arthrodesis at 10-year

follow up.[56] The patients most at risk for this issue are those who receive a single level procedure, especially if it involves the 5th or 6th vertebrae.[56]

4. Conclusion

Cervical spine surgery is a very successful option for combatting certain mechanical pathologies of the upper spine. Although complications are inherently associated with all surgical interventions involving the spine, careful preoperative planning and operative awareness can help minimize many of the potential devastating complications that are unique to cervical spine surgery due to the inherent anatomic variation seen amongst the general population. While the anterior approach is how the overwhelming majority of cervical spine surgery is performed, complications like dysphagia, dysphonia, and pseudoarthrosis are much more common with this approach relative to the posterior approach where infection, epidural hematoma, neurologic injury, pain, and adjacent segment disease are much more common.[2] Overall, with appropriate patient selection, preoperative planning, and intraoperative execution, spine surgery is an effective strategy for addressing an assortment of mechanical pathologies that plague the cervical spine.

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