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COMPLICATIONS OF ANTERIOR CERVICAL SPINE SURGERY: REVIEW OF THE LITERATURE

ANTERİOR SERVİKAL SPİNAL CERRAHİ KOMPLİKASYONLARI: LİTERATÜR GÖZDEN GEÇİRİLMESİ

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SUMMARY:

Anterior cervical spine surgery has long been used as a standard procedure in the surgical treatment of spondylosis, disc herniations, spine tumors, deformities, traumas, ossified posterior longitudinal ligament (OPLL) and vascular diseases. Various procedures for this approach generally have satisfactory outcomes, and low and manageable complication rates. However, life-threatening conditions may occur. Also, as new procedures and technologies develop, new complications are encountered. All of these complications should be considered during surgical planning to avoid catastrophic events and for satisfactory results.

Key words: Anterior cervical spine surgery, cervical spine surgery complications anterior cervical approach

Level of evidence: Review article, Level V

ÖZET:

Anterior servikal omurga cerrahisi; spondiloz, disk hernileri, omurga tümörleri, deformiteler, travma, ossifiye posterior longitudinal ligament ve vasküler hastalıkların tedavisinde uzun zamandır standart bir prosedür olarak kullanılmaktadır. Bu yaklaşım ile gerçekleştirilen çeşitli prosedürlerin genellikle tatminkar sonuçları ve hem az hem de kontrol edilebilir komplikasyon oranları vardır. Bununla birlikte, hayatı tehdit eden durumlar da gelişebilir. Ayrıca, yeni metodlar ve teknolojiler geliştikçe, yeni komplikasyonlarla da karşılaşılmaktadır. Felaketle sonuçlanabilecek durumlardan kaçınmak ve tatminkar sonuçlar elde edebilmek için, cerrahi girişimin planlanması sırasında tüm bu komplikasyonlar göz önünde bulundurulmalıdır.

Anahtar kelimeler: Anterior servikal spinal cerrahi, servikal spinal cerrahi komplikasyonları, anterior servikal yaklaşım

Kanıt Düzeyi: Derleme, Düzey V

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INTRODUCTION:

Anterior cervical spine surgery has long been used as a standard procedure in the surgical treatment of spondylosis, disc herniations, spine tumors, deformities, traumas, ossified posterior longitudinal ligament (OPLL) and vascular diseases. These pathologies affect the stability of spine, which means the protection of integrity in physiological loading limits without pain and neurological deficits. Therefore; the aim of anterior approaches should be providing the reconstruction of spine, eliminating neurologic compression and maintenance of stability.

Since the description of the anterior approach for cervical discectomy and fusion by Robinson and Smith[38] in 1955, anterior cervical approaches have become the most common procedures performed by spinal surgeons. In the advancing years, various surgeons have used plate-screw systems with fusion in addition to Robinson and Smith's technique[6]. In recent years, dynamic systems such as intervertebral cages and cervical disc prosthesis have been introduced for anterior stabilization. Besides, various minimally invasive interventions were identified that have satisfactory results. In 1996 Jho described microsurgical anterior cervical foraminotomy as a new minimally invasive method in the treatment of cervical disc herniation that protects the disc and allows enough neural decompression[23]. Then he reported the results of the same method for cervical spondylotic myelopathy in 1997[24]. In 2000 Saringer et al. modified Jho's technique and described uncoforaminotomy, then reported their series of 34 cases of cervical radiculopathy treated by this technique[39].

These procedures generally have satisfactory outcomes, and low and manageable complication rates. However, life-threatening conditions may occur. Also, as new procedures and technologies develop, new complications are encountered.

There are vulnerable important organs anterior to the cervical spine. These are trachea, esophagus, carotid artery, recurrent laryngeal nerve (RLN), and sympathetic nerve trunk anterior to the cervical spine. Also, dura, spinal cord, nerve roots and vertebral arteries are important structures likely to damage during anterior cervical spine surgeries. The complications which cause major morbidity/mortality are the most common ones. They usually occur intraoperative, early postoperative (within 1 week), and intermediate postoperative (1 to 6 weeks) periods and include esophageal injury, vertebral artery injury, dural tear, spinal cord/nerve root injury, airway compromise, epidural hematoma, radiculopathy, dysphagia, dysphonia, wound infection, and bone graft dislodgment. Longer term complications include adjacent segment disease and fusion failure[10]. All of these complications should be considered during surgical planning to avoid catastrophic events and for satisfactory results.

INTRAOPERATIVE COMPLICATIONS:

Esophageal injury:

Esophageal perforation is rare but a life-threatening complication. It occurs with an incidence of 0.02-3.4% [9,15,35,36]. Perforation occurs at upper esophagus or pyriform sinus of pharyngoesophageal junction. It is usually due to wrong placement of retractors, trauma by a high-speed drill or sharp instruments and prolonged retraction resulting in an ischemic injury. It is rarely recognized intraoperatively, but diagnosed within 10 days of surgery in many cases. However, in some cases symptoms develop several months/years after surgery[47]. Anterior plating increases the risk of delayed esophageal perforation[36] but plate removal is not usually performed. High mortality rates (4-50%) due to mediastinitis, sepsis or meningitis after esophageal injury have been reported[9,15,35]. Therefore, early diagnosis and treatment are important.

To avoid this complication, retractor teeth should be placed under the longus colli muscles, and esophagus should be protected by hand-held retractors while using high-speed drill. In case of any clear fluid or air leakage observation intraoperatively, esophagus should be immediately investigated and the tear should be repaired if found. If not, surgeon must be aware of the signs like postoperative sore throat, dysphagia, mis-swallowing, fever, tachycardia and pneumoderma which suggest esophageal injury[9,15,35]. Rapid contrast imaging and/or endoscopy should be performed in such suspected patients. Feeding tube placement should also be performed for these patients.

Delayed perforations are very rare and may be due to the chronic contact between the pharyngo-oesophageal wall and the instrument. Repetitive friction leads to successive necrosis, formation of traction-type pseudodiverticulum, perforation and abscess formation from the leaking fluid[16,55]. Some cases with a well-positioned hardware were reported[9,32,45] as well as other cases including graft dislodgement, screw migration or plate failure[13,17,43,51,55]. If any anterior migration of instrument or graft detected during follow-up, contrast imaging and/or endoscopy of esophagus should be considered.

Vascular injury:

The vertebral arteries arise from the subclavian arteries, then enter deep to the transverse process of the level of C6, or occasionally at the level of C7. They then proceed superiorly, in the transverse foramen of each cervical vertebra. Once they have passed through the transverse foramen of C1, they travel across the posterior arch of C1 and through the suboccipital triangle before entering the foramen magnum. The mean distance from the uncovertebral joint to the transverse foramen has been re- ported to be 5.5 mm in the subaxial vertebrae, although anatomic variants are common[10]. Curylo et al.[8] reported a 2.7% incidence of unilateral artery displacement,

with transverse foramen enlargement as far medial as the midvertebral body level.

Vertebral artery injury due to anterior cervical spine surgery is rare with an incidence of 0.1–0.5%, but often results in severe neurological deficit[33]. Most of the injuries occurred during the procedures including corpectomy[22]. Inter-uncovertebral distance decreases from caudal to cephalad. Therefore, the risk of injury is greater at cephalad vertebra. Excessively wide corpectomy and lateral bone removal, and loss of vertebral midline or orientation are the main reasons of vertebral artery injury[4].Vertebral artery tortuosity or other anomalies, such as vertebral artery located anterior to the transverse process, may result in intraoperative injury. So, preoperative contrast-enhanced computed tomography imaging is mandatory for the cases requiring uncovertebral joint resection[47].

In case of vertebral artery injury intraoperatively, compression of the bleeding point using gelform or cottonoids should be tried, and threads or vascular closure staples can be used for repair of arterial wall. When these trials fail, ligation of vertebral artery can be considered, but it may lead to cerebellar/brain stem infarction and the mortality rate is as high as 12%[47]. Intraoperative angiography before ligation is recommended to ensure adequate cerebral perfusion. Alternatively, injuries that appear to be controllable via direct tamponade may be treatable endovascularly via stent or coagulation, depending on the angiographic appearance of the contralateral circulation[10].

Carotid artery injury during anterior cervical procedures is quite rare[21]. Prolonged retraction of the common carotid artery may lead to lethal stroke[52]. Preoperative evaluation of the carotid artery should be considered for the patients with a history of previous stroke, and approach side should be discussed and long retraction should be avoided[47].

Dural injury:

Incidence of dural tear due to the anterior cervical spine surgery is 1% or less in many reports[54]. Subcutaneous cerebrospinal fluid (CSF) leakage may lead to wound healing failure, infection or dysphagia by mass effect[42].

In some cases dura can be directly repaired depending on the location of the defect. Widening the exposure and primary repairing of the defect with application of fibrin glue or sealant should be attempted. Because of the lack of a closed fascial space, as exists in the lumbar spine, inserting a lumbar CSF drain may be considered even if adequate repairing is done[7]. However, it is generally difficult to repair the dura directly because of limited space in anterior cervical procedures. In these cases, synthetic dural substitute and fibrin glue can be just placed on the dura followed by a lumbar CSF drain application[47].

Spinal cord and root injury:

Spinal cord and nerve roots are always at risk of anterior cervical spine surgery. The incidence of spinal cord injury during anterior cervical spine surgery is reported between 0.2% to 0.9%[10]. Patients with myelopathy, cervical kyphosis, spinal cord atrophy, spinal intability or fractures are at increased risk of spinal cord injury. Maintenance of systolic blood pressure over 80 mm Hg and avoidance of excessive extension or distraction of the neck during patient positioning are known precautions to prevent iatrogenic spinal cord injury[10].

Particularly during the surgery of the patients with marked instability or myelopathy, use of intraoperative neurologic monitoring with transcranial electric motor-evoked potential (tceMEP) monitoring and somatosensory-evoked potential (SSEP) seems feasible[28]. Hilibrand et al.[20] reported the sensitivity and specificity for detecting evolving motor tract injury with tceMEP was 100%, compared with a 25% sensitivity and 100% specificity with SSEP in their retrospective study of patients undergoing cervical spine surgery.

Interestingly, as a well documented but not clearly understood complication, C5 palsy may occur either after anterior or posterior surgeries of the cervical myelopathy. It is estimated to occur in 0–30% of the patients after the anterior cervical spine surgery, but the etiology is still unclear. There is higher incidence after anterior corpectomy+fusion than anterior discectomy+fusion, especially when surgery involves C3/4 and C4/5 segments[47]. Injury to the nerve root during surgery, nerve root traction due to the shift of cervical spinal cord after decompression, and spinal cord ischemia and reperfusion injury have been proposed as mechanisms of postoperative C5 palsy. However, pathogenesis has not been clarified and there is no effective method for prevention[47].

In case of neurological deterioration postoperatively, emergent magnetic resonance and/or computed tomography imaging should be performed to rule out hematoma or misplaced graft or instrument. In the absence of these pathologies, treatment with steroids, controlled hypothermia and maintenance of mean arterial pressure ≥ 90 mm Hg should be applied[20].

Recurrent laryngeal nerve injury:

Hoarseness after the anterior cervical spine surgery has been reported to be a consequence of RLN palsy[3]. However, vocal cord trauma during intubation, postoperative acid reflux, and laryngeal and vocal cord edema are the other factors causing hoarseness[1,25].

Right RLN leaves the vagus nerve and loops under subclavian artery, while the left RLN leaves vagus nerve at the mediastinum and passes over the aorta. After branching from vagus nerve, right nerve does not go into the tracheoesophageal groove until it approaches the cricothyroid joint, whereas left RLN

ascends within the tracheoesophageal groove[47]. Right RLN was thought to be easily injured by right side approach of the anterior cervical spine surgery, because it might cross the operative field[34,47]. However, the incidence of postoperative hoarseness does not differ by the side of approach[26]. The incidence of RLN palsy had been reported to be 2–3% [3,26]. Besides, a recent prospective study showed the incidence of hoarseness and subclinical laryngoscopic vocal code paralysis was 8.3%, 15.9% at 3–7 days, and 2.5%, 10.8% at 3 months after surgery, respectively[25]. RLN palsy seems more frequent than anticipated.

RLN injury can occur intraoperatively as a result of compression, blunt trauma, nerve division, neurapraxia, or postoperative edema. Apfelbaum et al.[1] found that pharyngeal tissues adjacent to the endotracheal tube were subject to significant compression. They indicated that endotracheal tube cuff pressure reduction to 15 mm Hg after retractor placement reduces the incidence of RLN injury from 6.4% to 1.7%.

Endotracheal tube cuff pressure monitoring and release after retractor placement may prevent injury to the RLN during anterior cervical spine surgery[47]. For patients suffering prolonged dysphonia following anterior cervical spine surgery, referral to a speech pathologist or otolaryngologist is appropriate to help determine the cause[10].

POSTOPERATIVE COMPLICATIONS:

Airway obstruction:

Acute airway obstruction after anterior cervical procedures is a life-threatening adverse event which must be evaluated and treated immediately. Airway obstruction is caused by retropharyngeal hematoma, edema of soft tissues, CSF leakage, graft or instrument displacement, or aspiration and the incidence is 1–6%[2,31]. It occurs minutes to 10 days after surgery, but most frequently, in 24–48 hours[47]. Recently, local retropharyngeal steroid administration is reported to reduce prevertebral soft tissue swelling[31], but careful hemostasis and avoidance of prolonged retraction are essential to prevent this catastrophic event[47]. Multi-level surgery (>2 disc-level), surgery cephalad to C4, bleeding more than 300 ml and long operation time (>90 min or >5 hours) are risk factors for postoperative airway obstruction[31]. Epstein et al.[12] recommended that patients to be kept intubated after multilevel anterior cervical spine procedures until they demonstrate adequate ventilatory weaning parameters while off of sedation, satisfactory air leak around a deflated endotracheal tube balloon, and bronchoscopic evidence of minimal airway swelling.

This adverse event can occur despite placement of a postoperative drain and adequate hemostasis at the time of wound closure due to increased blood pressure, coughing, vomiting, coagulopathy, or the use of an anticoagulant[10]. In case of the airway obstruction due to hematoma, early detection and hematoma evacuation are the keys to save patients[47].

Dysphagia:

Dysphagia is the most common adverse event following anterior cervical spine surgery[10]. Recent studies reported that a big percentage of patients undergoing anterior cervical spine surgery experience some degree of postoperative dysphagia, with rates ranging from 28% to 57%[30,44]. Risk factors for postoperative dysphagia include a longer duration of preoperative neck or shoulder pain, age >60 years[44], female sex[30], operations on two or more levels[30], involvement of C4–C5 and C5–C6 levels[30], revision surgery[30] and thicker anterior cervical plates[30].

Esophageal denervation, soft-tissue swelling and scar tissue formation are the most common reasons of swallowing difficulty after anterior cervical spine surgery[10]. Cervical immobilization, compression of instruments, CSF leakage, hematoma and injury to the nerves involved in swallowing are other possible reasons of swallowing difficulty[14].

Patients with marked postoperative dysphagia should be evaluated with lateral plain radiographs or computed tomography scan for bone graft dislodgement, retropharyngeal abscess, and postoperative edema or hematoma[10]. Contrast enhanced imaging and/or endoscopy may be considered to rule out esophageal damage. Use of corticosteroids for dysphagia remains controversial. Patients with persistent dysphagia or with suspected aspiration due to coughing, choking, or atelectatic changes on chest radiographs should undergo speech pathology evaluation and active swallow therapy[30]. In the patient with severe dysphagia that persists longer than 1 to 2 weeks, temporary feeding tube placement may be considered[10].

Graft extrusion or displacement:

Bone graft extrusion is a serious complication of anterior cervical spine surgery and generally requires revision surgery. It has been encountered mostly following multilevel cervical corpectomy procedures[40,50]. Wang et al.[50] reported 6.4% rate of graft migration or displacement in their review of 249 patients undergoing cervical corpectomy. They reported an increasing rate of migration with increasing levels of corpectomy, particularly in the procedures ending at C7. Sasso et al.[40] reported a rate of 6% failure after two-level anterior cervical corpectomy, and a rate of 71% failure after three-level corpectomy with fusion despite use of anterior plate. Other risk factors for graft extrusion include previous cervical laminectomy, osteoporosis, and graft overtensioning, all of which may contribute to vertebral body fracture and secondary graft dislodgement[10,11].

In general, a patient who requires corpectomy of two or more vertebral levels should be considered for simultaneous posterior instrumented spine fusion. Combining one or two-level corpectomy with discectomy allows segmental anterior plate fixation and may avoid the need for adjacent posterior fixation[10]. Use of a buttress plate without same-stage posterior instrumented fusion should be avoided because it likely does not reduce the incidence of graft extrusion and may result in air-way compromise[37].

Epidural hematoma:

Postoperative epidural hematoma is a rare but classical complication of cervical spine surgery[18]. Patients presenting with a new postoperative deficit should warn the surgeon about epidural hematoma[27]. Rapid surgery is a determinant factor of a full neurologic recovery[41]. The neurologic signs may be consistent with a lesion at the upper part of the cervical spinal cord rather than at the level of the surgical site. Therefore, an MRI examination should have been performed before any further surgery was undertaken[18]. However, postoperative cord dysfunction may also be caused by spinal cord injury during surgery and incorrect alignment of the spine associated with graft complication[53].

Multilevel surgical procedures and the presence of a preoperative coagulopathy are significant risk factors for epidural hematoma after spinal surgery[27]. It may be caused by arterial bleeding or bleeding from epidural veins[29]. Adequate hemostasis and drain placement should be applied especially during multilevel procedures. When intraoperative neurophysiologic monitoring is used, it should be continued through wound closure and reversal of anesthesia, as neurologic deficits resulting from hematoma formation can develop at the end of the surgical procedure[29].

Infection:

Infection is quite rare after anterior cervical spine surgery, with an estimated incidence of 0.2% to 1.6% [2]. However, the incidence is higher in the instance of esophageal perforation or an immunocompromised patient[10]. It rarely resists antibiotics. However, esophageal injury or osteomyelitis should always be kept in mind in case of persistent symptoms. Resistant organisms and persistent infections should be considered for anterior hardware removal and regrafting, with the addition of posterior stabilization and fusion if needed[10].

Adjacent segment disease:

Spondylotic changes occur at adjacent vertebra segments following anterior cervical fusion surgery[5]. In the recent systematic review of the articles with an average follow-up of 107 months after anterior cervical discectomy and fusion, the average incidence of asymptomatic adjacent segment degeneration is 47.33% and for symptomatic adjacent segment disease was 11.99% [5]. Long-term follow-up studies reported a rate between 2-15% revision surgery due to adjacent segment disease[19,46,48].

Cervical disc arthroplasty has been expected to preserve the range of motion of cervical segments and reduce the incidence of adjacent segment degeneration, however, the effect is still controversial[47]. A recent meta-analysis of prospective studies compared arthroplasty and single level fusion at 2 years to 5 years of follow-up[49]. The rate of adjacent level surgery was 6.9% after anterior cervical discectomy and fusion and 5.1 % after arthroplasty, with no statistical difference. In conclusion, there is no effective surgical procedure to reduce the incidence of the adjacent segment disease[47].

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