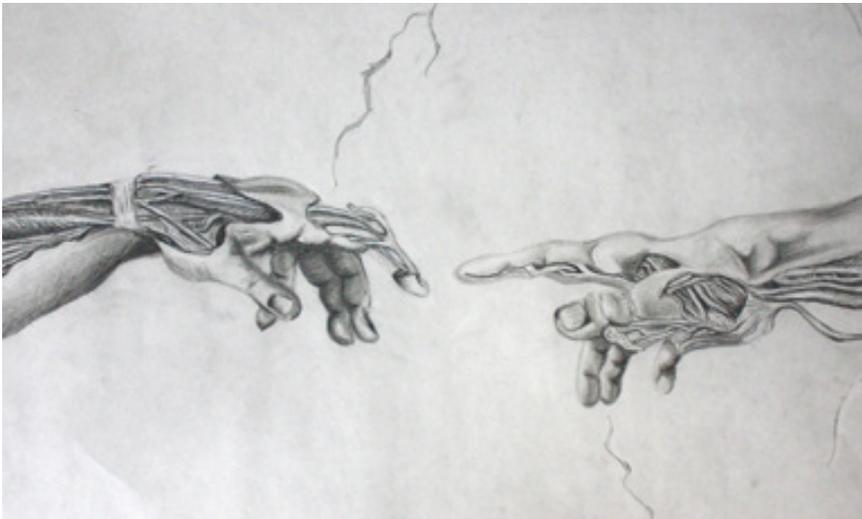

CASE REPORTS

Recovery from Quadriplegia Following Anterior Cervical Discectomy: Anesthetic Implications in Myelopathic Patients

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ABSTRACT



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In God's Image

Medium: Pencil Artist: Brielle Paolini

Objective: To report the anesthetic implications in a case of complete quadriplegia caused by a cervical epidural hematoma, following anterior cervical discectomy.

Background Summary: Quadriplegia is a rare but devastating complication of cervical spine surgery. Perhaps due to the infrequency of this or other perioperative complications, approaches to airway management, anesthetic maintenance, and re-emergence to consciousness vary widely among providers.

Methods: We report the clinical history, surgical procedures, and perioperative course of a patient undergoing anterior cervical discectomy and fusion at C7-T1 and artificial disc placement at C4-5.

Results: Rapid surgical re-exploration revealed an epidural hematoma that was then removed. The patient had nearly complete return of motor function at two-week follow-up.

Conclusions: Anesthesia providers should approach cervical spine procedures with great caution. Securing the airway with the patient awake followed by a neurologic exam may best protect unstable and/or myelopathic patients, and help to clarify etiology of new postoperative deficits. Rapid detection of new neurologic deficits may enable their correction through timely intervention.

Introduction

Quadriplegia following anterior cervical spine surgery is a known, albeit uncommon, postoperative complication. Stretch or direct trauma to the spinal cord and nerve roots, vascular compromise, and graft displacement or screw placement into the spinal canal rank among the more common causes of spinal cord injury and postoperative impairment. Less commonly, an expanding epidural hematoma can compress the spinal cord and result in profound neurologic compromise.¹ Aono et al. estimated the frequency of symptomatic epidural hematomas at 0.21% following anterior cervical discectomy and fusion procedures.² If identified and treated early, return of full or nearly full function can be expected. However, if postoperative dysfunction cannot be rapidly identified (by imaging or surgical re-exploration), the neurologic deficit may become permanent.

Some providers routinely approach patients with myelopathic symptoms or radiographic evidence of spinal cord impingement with great caution, choosing to intubate patients who are awake, both to minimize cervical manipulation and confirm baseline neurologic function before induction of anesthesia. This practice, however, is not the standard in all institutions, and as Manneren reported in a cohort of 327 patients undergoing spinal surgery, only 55 percent of those with spinal stenosis and only 45 percent of those with myelopathies were intubated awake.³ Often, caregivers elect to simply provide in-line stabilization with standard laryngoscopy to secure the airway.⁴ While rarely problematic, if presented with new postoperative deficits, one cannot say with certainty that airway and spinal manipulation during placement of the endotracheal tube were unrelated to the

outcome. A motor strength exam of all four extremities following intubation while awake minimizes this uncertainty.

Here we report a case of anterior cervical discectomy and fusion for cervical spinal stenosis, where complete quadriplegia was noted postoperatively. Close patient evaluation and cooperation between all involved personnel resulted in rapid identification and evacuation of an acute epidural hematoma. The case outlines the importance of rapid postoperative emergence and vigilance among surgeons and anesthesia providers to avoid adverse outcomes.

Case

A 48-year-old woman with cervical spondylotic myelopathy underwent anterior cervical discectomy and fusion at C7-T1, and an artificial disc placement at C4-5. The preoperative physical exam was remarkable for mildly diminished strength in the left arm, reduced sensation over the right lateral arm, and mild hyperreflexia in both upper and lower extremities without clonus. Her cervical range of motion was limited, but other airway indices remained favorable. The MRI indicated the two areas of cervical stenosis with spinal cord compression and signal change at C4-5 (Figure 1). Given this information, an awake fiberoptic intubation was chosen to minimize cervical motion, allow neurologic assessment during and after endotracheal tube placement, and position the patient for surgery prior to induction of anesthesia. The patient received a 4% lidocaine nebulizer in the holding area, was transported to the operating room, and placed in a position of comfort on the operating table. Sedation was provided but she remained appropriately responsive. Injections of 2% lidocaine were used to anesthetize the bilateral superior laryngeal nerves and bilateral lingual branches of the glossopharyngeal nerves. Once the fiberoptic scope was positioned just above the vocal cords, a 4% lidocaine solution was injected via an epidural catheter passed through the suction port. An uneventful fiberoptic intubation was performed and the patient was able to follow commands, move all four extremities with baseline strength, and be positioned for surgery prior to being anesthetized with propofol and rocuronium. An

arterial line was placed. Anesthesia was maintained with a combination of isoflurane, nitrous oxide, and a remifentanyl infusion with intermittently bolused rocuronium. Neurologic monitoring was not performed. The patient's blood pressure was maintained at or slightly above her baseline awake blood pressure. Surgery proceeded uneventfully with stable hemodynamics and oxygenation throughout. Blood loss was minimal.

Upon completion of the procedure, the patient appeared lethargic. While not voluntarily moving her extremities, she was breathing spontaneously, opening her eyes and protruding her tongue to command. She was extubated and transported to the post-anesthesia care unit (PACU) with supplemental oxygen. Upon arrival in the PACU, the patient was more alert and could speak. However, when instructed to move her arms or legs, she was unable to. She verbally confirmed she was attempting to but unable to move any extremities. The attending surgeon was called to the bedside and the decision was made to immediately return to the operating room for re-exploration. On arrival in the operating room, two additional anesthesiologists and one additional CRNA were called to assist. With a new deficit, a more expedient induction and intubation was planned. Induction was performed with propofol and succinylcholine. In-line stabilization was held and bag mask ventilation achieved with an oral airway. Two attempts to fiberoptically intubate were unsuccessful due to significant pharyngeal edema. An intubating laryngeal mask airway (LMA) was then placed and ventilation resumed. A cuffed endotracheal tube was then passed through the LMA with positive expired carbon dioxide, and bilateral breath sounds confirmed. Oxygen saturation remained at or above 94% throughout. The time from arrival in PACU until return to the operating room was approximately 20 minutes. The time from induction in the operating room until securing the endotracheal tube was 12 minutes. General anesthesia was maintained with oxygen and isoflurane to ensure maximum oxygenation, and the blood pressure was elevated to approximately 20 mm Hg above the patient's baseline with phenylephrine.

Lateral c-spine fluoroscopy performed during the second induction did not indicate any acute abnormality, such as a retropulsed graft, as was initially suspected (Figure 2). Exploration of the wound revealed a hemorrhaging epidural vein to the left side of the C4-5 artificial disk and a large adjacent blood clot behind the bone and confined to the spinal canal by the artificial disk. The hematoma was quickly evacuated and the vein cauterized. A solumedrol infusion was initiated per the spinal cord injury protocol. Following wound closure, the patient was again rapidly awakened from anesthesia and followed commands to include movement of all four extremities. She was extubated and transported to the PACU without incident. At her two-week surgical follow-up, she had return of full strength in all extremities except for her left deltoid muscle, which was 4-/5.

Discussion

An expanding epidural hematoma is a rare though potentially disastrous postoperative complication following cervical spine surgery. If not recognized and treated quickly, spinal cord injury may rapidly progress to the point of irreversibility. While the differential diagnosis for neurological dysfunction following cervical surgery is extensive, one can place airway manipulation and head and neck positioning low on this list by intubating high-risk patients while they are awake and obtaining a neurologic exam prior to induction of anesthesia. Unfortunately, the time and effort required for awake intubation while patients are awake may not always be perceived as necessary, given the rarity of postoperative neurologic complications. Hindman points out that while less than 1 percent of all lawsuits filed against anesthesiologists (from 1970-2007) concerned cervical injury, 11 percent of those lawsuits were attributed to airway management. Permanent and disabling injury was reported in nearly 70 percent of these claims.⁵ Awake fiberoptic techniques, whether by using topical anesthesia or direct nerve blocks, have patient acceptance and can be performed rapidly and safely (even by trainees) with minimal impact on operating room processes.^{6,7,8} The above case demonstrates why a four extremity motor exam in an intubated and positioned patient with preexisting cervical cord injury can help to differentiate

neurologic deficits upon emergence. Less than 15 minutes was required to obtain sedation, airway anesthesia, and intubation.

The importance of a rapid re-emergence to consciousness with subsequent neurological exam cannot be overemphasized. Even if extubation is not anticipated due to airway swelling, surgical complications or patient instability, this step is vital to rule out deficits that present immediately postoperatively.^{9,11} While there is no single method for obtaining a rapid, lucid emergence from anesthesia, the goal is always the same (a timely emergence with a calm patient who can quickly provide a reliable neurologic exam). Several principles hold true in most situations.

First, it is important to know the patient's preoperative neurologic baseline. Minimizing preoperative sedating drugs and using anesthetics that are cleared rapidly from the body or redistributed away from the brain in a quick and reliable manner are prudent practices. In general, patients tend to wake up more lucidly and with better tolerance of the endotracheal tube with opioid-based rather than volatile inhaled anesthetics. This may be due to a higher MACawake/MAC ratio for opioids (0.8 for opioids, 0.67 for nitrous oxide, and 0.3 for volatile inhaled agents). The analgesic properties of opioids tend to prevent coughing, bucking, or gagging on the endotracheal tube more effectively than volatile inhaled agents. Poor endotracheal tube tolerance on emergence both interferes with obtaining a neurologic exam prior to extubation, and can cause bleeding at the operative site due to hypertension and possibly excessive cervical movement from coughing or combativeness on the part of the patient. An additional advantage to an opioid-based emergence is that this class of drugs is reversible with titrated doses of naloxone if necessary. We chose remifentanyl for this case because it is eliminated rapidly and predictably (within minutes), facilitating a quick and lucid emergence to consciousness regardless of duration of infusion. With such drugs, however, an analgesic plan must be in place for post-operative pain after the remifentanyl has worn off. We prefer to titrate dosing of a quick-onset opioid such as fentanyl once patients are at their neurologic baseline, and then use longer-acting opioids such as hydromorphone if required.

Analogous to maintaining cerebral perfusion pressure in the setting of intracranial hypertension, patients with cervical cord compression and/or injury must have a blood pressure high enough to maintain adequate perfusion of at risk tissue in the spinal cord. Spinal cord blood flow has been extensively studied in animal models, and suggest that autoregulation in the spinal cord mimics that in the brain. Blood flow is well maintained between a mean arterial pressure between 60 and 120 mm Hg in adults.¹⁰ Compression of the spinal cord leads to a decrease in spinal cord blood flow; subsequent injury to the spinal cord leads to compromise of autoregulation, making spinal cord blood flow even more dependent on systemic blood pressure.¹¹ Thus, the deleterious effects of hypotension may be compounded in injured and/or compressed spinal cords. Although definitive data are lacking, most experts recommend early and aggressive intervention to maintain a mean arterial blood pressure above 85 mm Hg when cord injury is suspected.^{12,13,14} Although more aggressive hypertensive therapy may have advantages, it may convey a risk of further hemorrhage and edema.

Goals to smooth re-emergence after cervical surgery include obtaining a clear neurologic exam prior to extubation to maintain the ability to quickly readminister anesthesia if additional interventions are needed. If endotracheal tube intolerance makes an intubated exam impossible, the extubated patient should undergo a neurological exam before leaving the operating room. Prolonged emergence from unconsciousness or a patient who cannot perform a clear neurological exam are not desirable situations.¹⁵ Our patient was extubated and taken to recovery before undergoing a complete exam, which was not optimal. Vigilance of anesthesia providers, nurses, and surgeons allowed for rapid assessment of neurologic status once the patient was in the PACU. There was a high index of suspicion for a surgical complication leading to a direct return to the operating room for emergent reintubation and wound re-exploration. While some providers may have elected to do imaging studies in response to postoperative quadriplegia, the time required is valuable and may have been the difference between a potentially reversible lesion and a permanent one. We did obtain a fluoroscopy image, since it did not add to the time

needed to re-explore the patient's cervical spine and ruled out malposition of the artificial disk and intervertebral bone graft. Techniques based on x-ray imaging, such as fluoroscopy or CT scanning, will reveal problems such as hardware malposition or bony misalignment, but provide little information regarding the presence or absence of hematomas or spinal cord contusions. MRI would be the imaging modality of choice for such cases. However, even in the best of situations, getting an MRI scan would delay re-exploration by 30 minutes or more. In our case, such a delay would likely have resulted in some significant permanent neurologic deficit.

Conclusion

Despite the infrequency of adverse outcomes, anesthesia providers should be aware of the potential complications associated with cervical spine surgery. Quadriplegia is physically and emotionally devastating to patients and their families. Our case demonstrates the importance of endotracheal intubation in awake patients who are at increased risk for cervical cord injury, both to protect patients and to help delineate the cause of injury if they awaken with new deficits. A rapid re-emergence to consciousness and neurologic exam allow immediate intervention if needed. If a complication can be recognized prior to extubation, minimal time is lost identifying and correcting the cause. Immediate surgical re-exploration is often warranted in the face of new neurologic deficits of probable reversible etiology (hematoma), and may be the difference between a patient's return of function and permanent paralysis.

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