The Incidence of Vertebral Artery Injury in Cervical Spine Surgery

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Disclosures: None to declare.

Introduction: Vertebral artery injury (VAI) is a rare but devastating complication of cervical spine surgery. Clinical sequelae of VAI include intraoperative hemorrhage, postoperative bleeding, pseudoaneurysm formation, neurological deficits, thrombosis, and embolism. To prevent VAI, a thorough understanding of vertebral artery anatomy is essential when performing anterior or posterior cervical spine procedures. The vertebral artery (VA) is a branch of the subclavian and is divided into 4 recognized segments, V1-V4. The typical course is for the artery to run anterior to C7 transverse process and enter the transverse foramen at C6 traveling cephalad through C3 transverse foramen. The artery enters C2 transverse foramen and travels posteriorly to C1 before entering the dura and joining the contralateral artery to form the basilar artery. Despite this typically observed anatomy, variations exist which present significant challenges during cervical spine surgery. MRI evaluation of the vertebral artery in patients with spinal pathology demonstrates midline shift of the VA in 7.6% of patients, anomalous VA in 11.6% of subjects, and atypical entry into more cephalad transverse foramen in 8% of patients[1]. Additionally, surgical factors including excess lateral drilling, loss of anatomic landmarks, or misplaced instrumentation can also lead to iatrogenic VAI.

Given the morbidity in patients with VAI, characterizing the incidence of this complication is essential to appropriately counsel patients undergoing cervical spine operations. As there is no large national epidemiological study characterizing VAI incidence among patients undergoing cervical spine surgery, this study aims to provide a generalizable assessment of iatrogenic VAI during cervical spine surgery in the United States.

Methods: A national insurance database, PearlDiver, was used to access patient data from 2010-2020 who underwent Anterior Cervical Discectomy and Fusion (ACDF), Anterior Corpectomy, Posterior Cervical Fusion (C3-C7), or C1-C2 posterior fusions for degenerative pathologies. Patients with myelopathy, spondylosis, radiculopathy, stenosis, or spondylolisthesis were included while patients with neoplasm, infection or trauma were excluded. Patients who experienced a vertebral artery injury were identified within the database and frequencies for the different procedures were compared.

Results: A total of 224,326 patients were included in this study: 173,904 with ACDF; 22,513 with anterior corpectomy; 27,091 with posterior cervical fusion; 818 with C1-C2 posterior fusion. The highest number of patients in each of the procedure groups had degenerative disc disease followed by cervical radiculopathy as their preoperative diagnosis. 97,521 patients (56%), 12,718 patients (56%), and 23,215 patients (86%) underwent multi-level ACDF, Anterior Corpectomy, and posterior cervical fusion, respectively. Overall incidence of VAI across all procedures was found to be 0.03%. The highest incidence of VAI was estimated in C1-C2 posterior fusion (0.12-1.10%). The number of VAI cases after anterior corpectomy, ACDF, and posterior fusion were 14 (0.06%), 43 (0.02%) and 26 (0.01%) patients, respectively (Table 1). Hospital length of stay for patients with VAI was found to be 8±5 days compared to 4±11 days for patients without VAI after undergoing their cervical spine procedure (p=0.0015).

Discussion: The overall incidence of VAI among 224,326 patients included in this study was found to be 0.03%, which is less than the previously reported incidence of VAI in the literature. C1-C2 posterior fusion was found to be the highest risk procedure studied which is consistent with previous reports. Additionally, our study demonstrates that anterior corpectomy is a relatively high risk procedure with an incidence three and six times greater than ACDF and posterior fusion, respectively. Furthermore, patients who experienced a VAI had a length of stay twice as long which demonstrates the high healthcare burden caused by these injuries when they occur. A potential strategy for mitigating risk of VAI among patients undergoing cervical spine surgery is through pre-operative formal vascular imaging. Although this may not be necessary for lower risk procedures, physicians may consider additional studies if planning for higher risk C1-C2 posterior fusions or anterior corpectomies. Although VAI incidence among different cervical spine procedures varies significantly, understanding this variability allows surgeons to appropriately counsel patients.

Significance/Clinical Relevance: To the best of our knowledge, this is the largest study to date investigating the incidence of VAI in patients undergoing cervical spine surgery in the United States. Reporting national epidemiology of VAI with associated cervical spine procedures allows physicians to appropriately counsel patients on risks and develop mitigation strategies including implementation of additional preoperative imaging.

References:

[1]Eskander, M. S. *et al.* Vertebral Artery Anatomy: A Review of Two Hundred Fifty Magnetic Resonance Imaging Scans. *Spine* **35**, 2035–2040 (2010).

VAI Incidence								
	ACDF		Anterior corpectomy		Posterior fusion		Posterior fusion C1-C2	
	N	%	N	%	N	%	N	%
Total	43	0.02	14	0.06	26	0.01	<10	0.12-1.10*

Table 1. VAI incidence by procedure
VAI: vertebral artery injury; ACDF: anterior cervical disc fusion. * Denotes calculated frequency