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Clinical Study

Vertebral artery injuries in cervical spine surgery

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Abstract

BACKGROUND CONTEXT: Vertebral artery injuries (VAIs) are rare but serious complications of cervical spine surgery, with the potential to cause catastrophic bleeding, permanent neurologic impairment, and even death. The present literature regarding incidence of this complication largely comprises a single surgeon or small multicenter case series.

PURPOSE: We sought to gather a large sample of high-volume surgeons to adequately characterize the incidence and risk factors for VAI, management strategies used, and patient outcomes after VAI.

STUDY DESIGN: The study was constructed as a cross-sectional study comprising all cervical spine patients operated on by the members of the international Cervical Spine Research Society (CSRS).

PATIENT SAMPLE: All patients who have undergone cervical spine surgery by a current member of CSRS as of the spring of 2012.

OUTCOME MEASURES: For each surgeon surveyed, we collected self-reported measures to include the number of cervical cases performed in the surgeon's career, the number of VAIs encountered, the stage of the case during which the injury occurred, the management strategies used, and the overall patient outcome after injury.

METHODS: An anonymous 10-question web-based survey was distributed to the members of the CSRS. Statistical analysis was performed using Student *t* tests for numerical outcomes and chi-squared analysis for categorical variables.

RESULTS: One hundred forty-one CSRS members (of 195 total, 72%) responded to the survey, accounting for a total of 163,324 cervical spine surgeries performed. The overall incidence of VAI was 0.07% (111/163,324). Posterior instrumentation of the upper cervical spine (32.4%), anterior corpectomy (23.4%), and posterior exposure of the cervical spine (11.7%) were the most common stages of the case to result in an injury to the vertebral artery. Discectomy (9%) and anterior exposure of the spine (7.2%) were also common time points for an arterial injury. One-fifth (22/111) of all VAI involved an anomalous course of the vertebral artery. The most common management of VAI was by direct tamponade. The outcomes of VAIs included no permanent sequelae in 90% of patients, permanent neurologic sequelae in 5.5%, and death in 4.5%. Surgeons at academic and private centers had nearly identical rates of VAIs. However, surgeons who had performed 300 or fewer cervical spine surgeries in their career had a VAI incidence of 0.33% compared with 0.06% in those with greater than 300 lifetime cases ($p=.028$).

CONCLUSIONS: The overall incidence of VAI during cervical spine surgery reported from this survey was 0.07%. Less experienced surgeons had a higher rate of VAI compared with their more

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experienced peers. The results of VAI are highly variable, resulting in no permanent harm most of the time; however, permanent neurologic injury or death occur in 10% of cases.

Keywords: Cervical spine; Surgery; Complications; Vertebral artery injury

Introduction

Vertebral artery injury (VAI) is a rare but serious complication of cervical spine surgery, with the potential to cause catastrophic bleeding, permanent neurologic impairment, and even death.

The vertebral artery is at risk during both anterior and posterior procedures of the cervical spine and can be injured during exposure, decompression, or instrumentation. Anomalies in the course of the artery can increase the likelihood of injury, particularly if they are not appreciated preoperatively. Up to 13.4% of vertebral arteries enter the cervical spine at a level other than C6 [1]. Curylo et al. [2] reported that 2.7% of cadaver specimens studied had a tortuous vertebral artery course, while Eskander et al. found 7.6% of cervical spine magnetic resonance images revealed midline migration of the artery [3].

The highest reported rates of VAI are associated with anterior cervical surgery at 0.2% to 0.5% [4–6] and with posterior C1–C2 transarticular fixation for atlantoaxial instability at 0% to 8.2% [7–9]. These reports are primarily from a single surgeon or smaller multicenter case series with as few as 41 patients. Given how infrequently VAI occurs, it is difficult to identify the true incidence with smaller sample sizes. The purpose of this study was to gather a large sample of high-volume surgeons to attempt to clarify the incidence and risk factors for VAI.

Materials and methods

An anonymous 10-question survey was sent out to all of the Cervical Spine Research Society (CSRS) members. The questionnaire asked each surgeon to record the total number of cervical spine cases performed in their career and how many VAIs they had encountered as the primary surgeon. Specific details were then elicited for each incidence of VAI, including how many years in practice at the time of injury, the stage of the case during which the injury occurred, whether there was an anomalous artery involved, management strategies of the arterial injury, and patient outcomes.

Stages of the case when the injury occurred were divided into exposure, decompression, or instrumentation. Exposures were noted to be anterior or posterior. Decompression methods were documented as anterior foraminotomy, anterior release, anterior corpectomy, posterior foraminotomy, or posterior laminectomy. Instrumentation options were divided anatomically into anterior upper cervical (C1–C2), anterior subaxial, posterior upper cervical (Occiput–C2), or posterior subaxial.

Management included as many of the following options as were used by the surgeon: tamponade, decrease blood pressure, increase blood pressure, blood transfusion, intravenous fluids, calling a partner, calling a vascular surgeon, calling interventional radiology, artery ligation, arterial repair, arterial stent, embolization, insertion of a screw, and use of electrocautery. Patient outcomes were noted as no harm, temporary neurologic deficit, permanent neurologic deficit, cerebellar infarct, and death.

Statistical analysis to analyze varying rates of VAI among groups of surgeons for continuous variables was performed using Student *t* test. Chi-squared tests were performed for categorical variables. Statistical significance was defined as a p value of $<.05$. All statistical analysis was performed using SPSS version 20.0 (IBM, Chicago, IL, USA).

Results

Demographics

One hundred forty-one CSRS members (of 195 total, 72%) responded to the survey. Seventy percent of respondents worked in an academic center, 15% worked in a private practice model that included the training of residents and/or fellows, and 15% were in a purely private practice model. There were an equally proportionate number of cases from each practice setting. The average surgeon responding performed just over 1,158 cervical spine surgeries (range, 10–5,000) in their career for a total of 163,324 cervical spine surgeries included in our analysis.

Arterial injury

A total of 111 VAIs were reported for an overall incidence of 0.07%. Sixty-eight (48.8%) surgeons admitted encountering at least one VAI in their career, whereas 73 surgeons had never encountered a VAI. The average number of VAIs per surgeon was 0.78 (range, 0–6) (Fig. 1). The average career volume for those who had encountered a VAI was 1,359 cervical cases compared with 971 for those without a VAI in their career. The individual surgeon rate of VAI ranged from 0% to 3.8% (average, 0.148%). The average VAI rate of surgeons involved with resident/fellow teaching and those in a purely private practice setting were identical, at 0.148% ($p=.998$). The VAI rate for surgeons who had performed 300 or fewer cases in their career was 0.528% (range, 0–3.8%) compared with 0.074% (range, 0–0.6%) for the 118 surgeons who had performed more than 300 cases ($p=.028$). The mean career year for VAI occurrence was