



The Vertebral Artery Cave at C2: Anatomic Study with Application to C2 Pedicle Screw Placement

R. Shane Tubbs¹, Andre Granger¹, Christian Fisahn^{1,3}, Marios Loukas², Marc Moisi³, Joe Iwanaga³, David Paulson³, Shiveindra Jeyamohan³, Jens R. Chapman³, Rod J. Oskouian³

■ **OBJECTIVE:** Knowledge of the course of the vertebral artery during instrumentation is of paramount importance. It has been shown that erosion of the C2 pedicle and body can occur due to pulsations of the adjacent vertebral artery. This often results in a “cave” for this segment of the artery. The descriptions of this anatomy are limited. The current study was performed with the hope that these data will be of use to spine surgeons during C2 instrumentation.

■ **METHODS:** In 40 human adult C2 bone specimens, the position of the vertebral artery in relation to the undersurface of the superior articular facet, pedicle, and C2 body was observed. A classification system was used to better describe these relationships. Pedicle screws were then placed into selected examples of each type.

■ **RESULTS:** We found type 0 specimens, with no cave, on 8 sides (10%). Types I, II, and III caves with minimal, moderate, and significant encroachment of the pedicle were observed on 40%, 35%, and 27.5% sides, respectively. Type IV caves with erosion into the lateral C2 body and undersurface of the superior articular facet were observed on 12.5% of sides. Although larger caves were found on left sides, this did not reach statistical significance. Pedicle screw placement for types III and IV were most likely to enter the vertebral artery cave ($P < 0.05$).

■ **CONCLUSIONS:** Additional osteologic data regarding the course of the vertebral artery while within C2 may decrease morbidity during surgery in this region.

INTRODUCTION

Occipitocervical, atlantoaxial, and subaxial pathology can be due to different pathologies. Trauma, degenerative/inflammatory changes, congenital/developmental malformations, infectious processes, and malignancy are among the main causes of these pathologies.¹⁻³ Several surgical approaches to treating instability in this area have been used.^{1,4-8} These techniques include the use of pedicle screws.⁹⁻¹³

Due to the anatomic variation of structures (e.g., vertebral artery) present in the vicinity of the C2 vertebral body, instrumentation at this level should be preceded by careful mapping of the area.¹⁴⁻¹⁶ These variants, if undetected before instrumentation, pose a risk to the patient. A knowledge of the possible variations of the artery at this level will help in minimizing its injury.^{14,17,18} Placement of screws into C2, although more studied presently than before, may still lead to breach of the vertebral artery cave (Figures 1–6). We define the vertebral artery cave as a combination of 2 earlier terms—the vertebral artery groove and the high riding vertebral artery.¹⁹⁻²¹ The vertebral artery groove is represented by the medial deviation of the artery, whereas the high riding vertebral artery extends superiorly deeper into the undersurface of the superior articular facet than normal. In this article, the anatomy of the vertebral artery cave is explored, paying special attention to its application to C2 pedicle screw placement.

METHODS

In 40 human adult C2 dry bone specimens, the position of the vertebral artery in relation to the undersurface of the superior articular facet, pedicle, and C2 body was observed. In addition, thin-cut computed tomography (CT) images with 3-dimensional (3D) reconstruction were performed through the specimens. Finally, the superior articular facet was removed with a drill, therefore the

Key words

- Anatomy
- Axis
- Complications
- Spine
- Surgery

Abbreviations and Acronyms

- 3D: 3-dimensional
CT: Computed tomography

From the ¹Seattle Science Foundation, Seattle; ³Swedish Neuroscience Institute, Swedish Medical Center, Seattle, Washington, USA; and ²Department of Anatomical Sciences, St. George's University, Grenada

To whom correspondence should be addressed: Christian Fisahn, M.D.
[E-mail: christian.fisahn@gmail.com]

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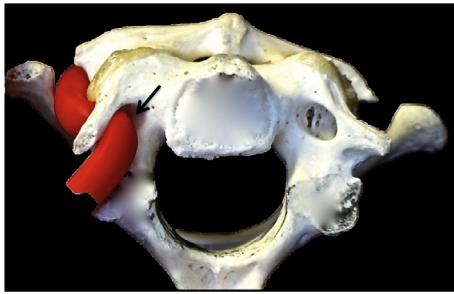


Figure 1. Inferior view of C2 with articulated C1 in the background. The vertebral artery cave (*left*) is illustrated medial to the displaced vertebral artery represented here by rubber tubing (*arrow*).

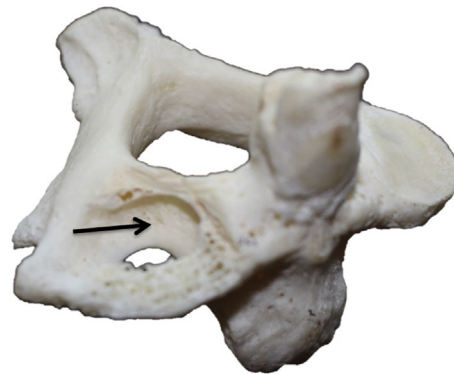


Figure 4. Same as **Figure 3** with an anterolateral perspective of the vertebral artery cave (*arrow*).

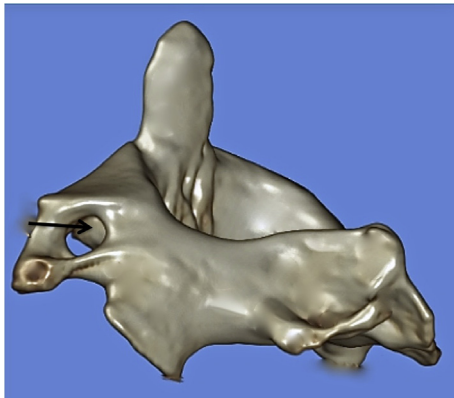


Figure 2. A 3-dimensional reconstruction of thin-cut computed tomographic images of C2 noting the left vertebral artery cave (*arrow*).

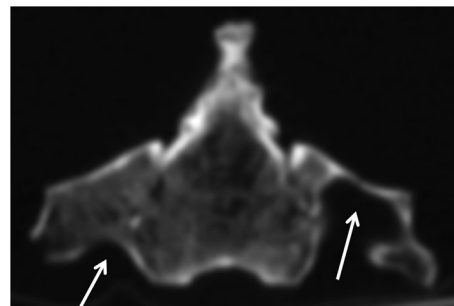


Figure 5. Coronal computed tomographic image illustrating a left-sided large and right-sided small vertebral artery caves (*arrows*).



Figure 3. Dry bone specimen of C2 with right superior articular facet removed to illustrate the lateral edge of the vertebral artery cave (*arrow*).

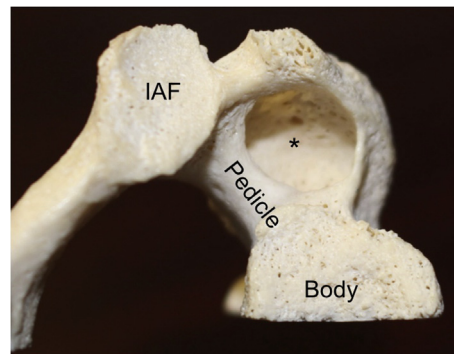


Figure 6. Inferior view of left-sided C2 illustrating the relationships between the vertebral artery cave (*) and surrounding structures such as the inferior articular facet (IAF).

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