

# Simultaneous lateral and posterior ponticles resulting in the formation of a vertebral artery tunnel of the atlas: Case report and review of the literature

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## Abstract

*The foramen arcuale is infrequently found and is potentially a clinically/surgically significant anatomical variation of the atlas. When present, the vertebral artery travels through this bony ring after exiting the transverse foramen of the atlas and prior to entering the cranium. We present a case of an adult female skeleton noted to harbor both a foramen arcuale and a lateral ponticle that resulted in the formation of a canal for the vertebral artery. The literature regarding these osteological structures is reviewed regarding their presence and potential clinical significance. The simultaneous occurrence of fully developed lateral and posterior ponticuli resulting in encasement of the third part (atlantal segment) of the vertebral artery appears to be very rare. Based on the literature regarding only foramina arcuale and their presence predisposing one to symptomatic entrapment, additional compression, as seen in our specimen, of the vertebral artery by a lateral ponticle could very likely result in stenosis of the vertebral artery.*

**Key words:** anatomy, neck, craniocervical, atlas, cervical, variation

## Introduction

The V3 segment of the vertebral artery, as it exits the transverse foramen of the atlas, travels in the groove for the vertebral artery (sulcus arteria vertebralis) on the posterior arch. Rarely, this groove may be converted into a bony foramen (foramen arcuale) [12] by the presence of a complete posterior ponticle connecting the superior articular facet to

the posterior arch. Some have found that the decompression of the vertebral artery in the foramen arcuale resulted in the cessation of vertigo [15,24]. Lateral ponticles (bony bridges) of the atlas have also been described but more rarely. These spicula extend from the superior edge of the lateral mass of C1 to fuse with its posterior root of the transverse process. The simultaneous occurrence of unilateral lateral and posterior ponticles appears to be very rare [25].

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**Fig. 1.** Posterolateral view of the case report presented herein. Note the course of the vertebral artery represented by the pipe cleaner

We now describe the concurrent presence of complete posterior and lateral ponticles resulting in the formation of a bony canal for the vertebral artery.

## Case Report

Upon routine examination of the skeletal material (75 skulls and attached cervical vertebrae) housed in our anatomical laboratory at the University of Alabama at Birmingham, an adult female specimen was noted to harbor a left sided bony canal for the vertebral artery (Fig. 1). This channel was formed by the simultaneous presence of both a lateral and posterior complete bony ponticulus. No other bony malformations were noted on this specimen. No such vascular channel was found on the right side of this specimen. The area of the foramen arcuale was 12.5 mm<sup>2</sup>. The length of the lateral and posterior ponticles was 7 and 12 mm, respectively.

## Discussion

The arcuate foramen has been reported with an incidence of 1.14 to 37% [1,3,4,7,9-12,14,17,20,22,26,27]. Stubbs [23] found that a complete foramen was commoner in males and that a partial foramen was greater in frequency in females. Other authors have found a slightly greater occurrence in males [18]. However, the foramen arcuale has been documented in children as young as two years old [2] and thus some have commented that this structure is simply a regressive and disappearing morphological phenomenon [13]. Lateral ponticles (bridges) have a reported incidence of 1.8 to 3.8% [9,11,13]. Some have posited

that the lateral and posterior ponticles of the atlas may be remnants of the proatlas, the so-called "occipital vertebra" [6,25], while others have suggested that they represent ossified primitive ligaments or parts of the posterior atlanto-occipital ligament [17,19]. Both lateral ponticles and arcuate foramina can be identified on radiographs [5,7,18,20]. Buna et al. [2] believe the lateral ponticuli represent rudimentary transverse processes of the proatlas. Curiously, a bony ring of the vertebral artery is a common structure in other vertebrates [13]. Taitz and Nathan [25] stated that the foramen arcuale might be considered an accessory transverse foramen. These same authors, in a study of 672 atlases, identified 9 with both posterior and lateral ponticles. Of these, 7 had unilateral lateral and posterior ponticles. It is not clear, however, how many had a complete posterior ponticle and hence a foramen arcuale. Kavakli et al. [11], in a study of 86 atlases, found only one with simultaneous posterior and lateral ponticles, although it is not clear if these existed unilaterally and if so if they formed complete foramina. Hasan et al. [9] examined 350 atlases from north Indians and found simultaneous unilateral lateral and posterior ponticles in 1.14% of this group. These authors defined this cohort as having a Class VI representation and believed that this morphology had not been previously reported in the literature.

Barre and Lieou [16] have described a syndrome with symptoms of headache, vasomotor disturbances of the face and recurrent disturbances of swallowing and phonation and hypothesized that these symptoms were due to alternations of the blood flow within the vertebral arteries and its associated peri-arterial sympathetic plexus. Limousin [16] has reported good results in patients with this syndrome and an identified foramen arcuale in which the foramen was fractured and a peri-arterial sympathectomy was performed. Li et al. [15] placed the foramen arcuale in the differential diagnosis for vertigo and found satisfactory results in eleven patients that underwent decompression of the vertebral artery in such a bony ring. Similarly, Sun [24] found cessation of vertigo in 69 patients undergoing decompression and sympathectomy of the vertebral artery within a foramen arcuale. Cushing et al. [6] found a foramen arcuale in 8 of 11 patients with vertebral artery dissection and occlusion. The site of arterial injury was at the level of this bony variation in

all cases. As more than 50% of head rotation occurs at the atlantoaxial joint, the vertebral artery is most vulnerable to compression and stretching at this level; thus additional compression/tethering of this vessel by a foramen arcuale may compound its predisposition to injury. During flexion of the neck, the vertebral artery glides superiorly and anteriorly relative to the posterior arch and this is most likely to occur at the level of the lateral masses of the atlas than at more caudal sites in the neck [16]. Anatomical studies have shown that the left vertebral artery is often larger, smaller, or equal in size to the right vertebral artery in 45, 21, and 34%, respectively [3]. Cellier and Georget [5] reported a 35-year-old male with Wallenberg Syndrome (lateral medullary syndrome) that developed following chiropractic manipulation of the cervical spine. This patient was found to have dissecting aneurysms of the vertebral arteries and bilateral foramina arcualae. Posterior ponticuli of the atlas have been found by one study to be associated with migraine and cervicogenic headache [21]. Lastly, Gross [8], in a report of basal subarachnoid hemorrhages at autopsy, found a foramen arcuale in 7 of 13 subjects of which it was seen bilaterally in 2 subjects.

Surgical stabilization of the C1-C2 joint is typically accomplished through reduction and fusion of the atlantoaxial complex with internal fixation via a posterior cervical approach. Huang et al. [10] have described a case of cervical instability in which a previously unidentified foramen arcuale precluded a C1 lateral mass screw fixation in a patient with rheumatoid arthritis. Young et al. [28] have commented that this variation may be mistaken for a widened posterolateral aspect of the posterior arch of the atlas so that placement of lateral mass screws at C1 can be difficult.

In conclusion, the simultaneous occurrence of fully developed lateral and posterior ponticuli resulting in encasement of the third part of the vertebral artery appears rare. Based on the literature regarding only foramina arcuale and their presence predisposing one to symptomatic entrapment, additional compression, as seen in our specimen, of the vertebral artery by a lateral ponticle could result in pathology.

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