Case report

BILATERAL FORAMINA ON THE POSTERIOR ARCH OF THE ATLAS

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RESUMEN

Durante la disección de la región cervical de diez cadáveres (5 varones y 5 mujeres, con edad media de 81,66 años) de una población de Escocia, se observaron dos especímenes con canales bilaterales de las arterias vertebrales y otro ejemplar con un canal vertebral unilateral en el arco posterior del atlas (C1). En estas muestras, se observó que la tercera parte de las arterias vertebrales pasan a través del foramen accesorio ubicado en el arco posterior del atlas. Anomalías del atlas y la arteria vertebral no son comúnmente reportadas en la literatura; sin embargo, son importantes debido a su importancia en el diagnóstico y tratamiento clínico. Forámenes bilaterales en el arco posterior de C1 no se han informado anteriormente en una población escocesa. Para los neurocirujanos y radiólogos la presencia de este rasgo no métrico es importante a la hora de realizar operaciones o en la interpretación de esta zona de la anatomía.

***Palabras clave**: atlas, orificio, arco posterior, anomalías congénitas.*

ABSTRACT

During dissection of the cervical region of ten cadavers (5 males, 5 females: mean age 81.66 years) from a Scottish population, two specimens were observed to have bilateral vertebral artery canals and a further specimen had a unilateral vertebral canal on the posterior arch of the atlas (C1): in these specimens the third part of the vertebral artery passed through the accessory foramen. Anomalies of the atlas and vertebral artery are not commonly reported in the literature; however they are important due to their significance in clinical diagnosis and treatment. Bilateral foramina in the posterior arch of C1 have not been previously reported in a Scottish population. The presence of this non-metric trait is important for neurosurgeons and radiologists who may be operating on or interpreting this area of anatomy.

***Key words: atlas**, foramen, posterior arch, congenital anomalies.*

INTRODUCTION

The atlas is a ring-shaped vertebra consisting of bilateral masses connected by anterior and posterior arches (Scheuer and Black, 2000): it has neither a vertebral body nor a spinous process. The anterior arch has an anterior tubercle and facet for articulation with the odontoid process of the axis on its anterior and posterior surfaces respectively. The posterior arch has a posterior tubercle on its posterior surface and a groove for the vertebral artery and suboccipital nerve superiorly. Each lateral mass consists of superior and inferior facets which articulate with the occipital condyles of the skull and the superior articular facet of the axis, respectively.

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There is a foramen transversarium in each transverse process through which the vertebral artery passes (Palastanga et al, 2006; Standring, 2008; Moore et al, 2010) following which it then passes posteromedially behind the superior articular process of the atlas before entering the skull through the foramen magnum (Standring, 2008).

Anomalies and anatomical variations of the atlas are not common and are referred to by different names: accessory foramen (Nayak, 2008), arcuate foramen (Cushing et al, 2001; Young et al, 2005), Kimmerle anomaly - an abnormal foramen formed by a calcified ligament (Barsukov et al, 1992; Koutsouraki et al, 2010; Prakash et al, 2010), posterolateral tunnel (Hasan et al, 2001) and posterior ponticulus (Hasan et al, 2001; Koutsouraki et al, 2010). Although the presence of an additional foramina in the posterior arch of the atlas has been reported in 3% to 15 % of the population (Cushing et al, 2001), relatively few studies have been conducted to evaluate such variations (Cushing et al, 2001; Hasan et al, 2001; Young et al, 2005; Nayak, 2008; Prakash et al, 2010). Due to the different appearance of accessory foramina associated with the posterior arch, the atlas can be classified as being one of six distinct types (Hasan et al, 2001): I, classical impression for the vertebral artery; II, deep groove for the vertebral artery; III, partial posterior ponticulus (bony extension from the lateral mass to the transverse process); IV, complete posterior ponticulus; V, lateral ponticulus; and VI, posterolateral tunnel.

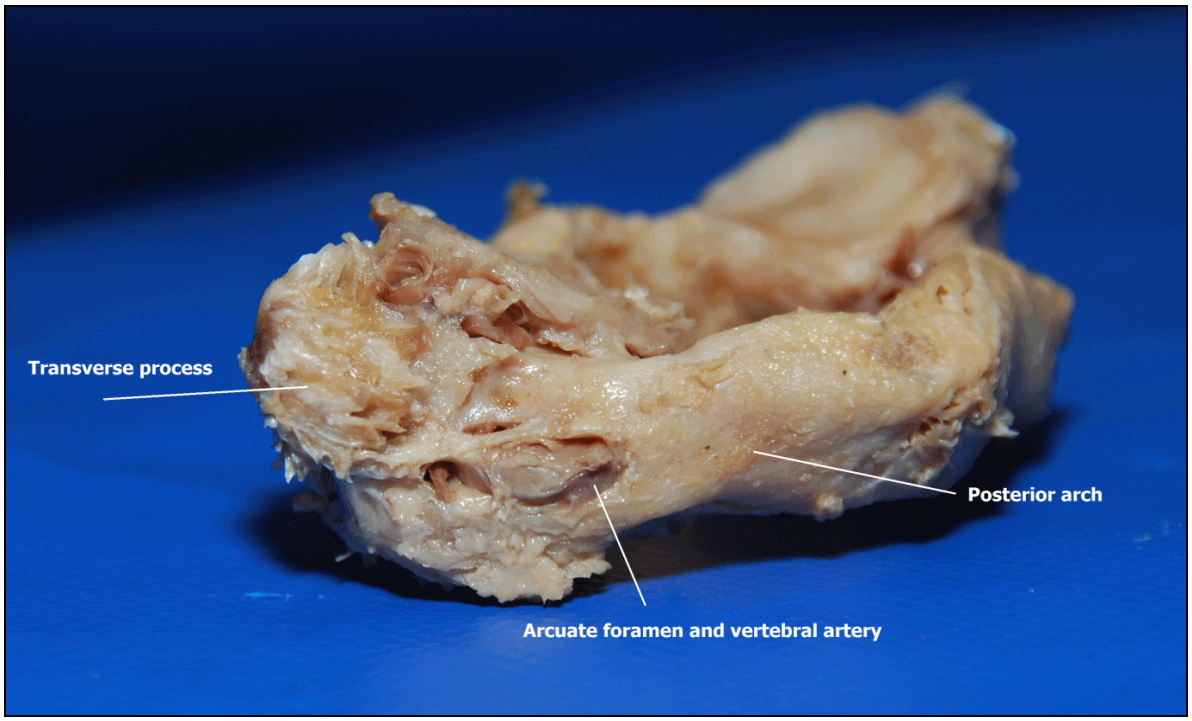

Figure 1 - Left lateral view of atlas showing the vertebral artery passing through the arcuate foramen.

CASE REPORT

During dissection of 5 male and 5 female cadavers (mean age 81.66 years) in which the atlas (C1) was removed, two cadavers had complete bilateral ossified foramina (arcuate foramina) on the posterolateral aspect of the posterior arch of the atlas and one had an unilateral (left) ossified foramen (Figures. 1, 2, 3), corresponding to group VI (Hasan et al, (2001). The foramina were circular (mean diameter 6.54 mm) and contained the vertebral artery which then entered the vertebral canal piercing the dura mater to unite with the opposite side artery to form the basilar artery. No fusion was observed between the atlas and occipital bone or between the atlas and axis. There were no anomalies or anatomical variations associated with other parts of the atlas (anterior and posterior arches) or with the atlantoaxial and/or atlantooccipital joints. The

surrounding soft tissue structures, in terms of muscles, ligaments and neurovascular system, also appeared normal. As the specimens were bequests to the Centre no medical information was available regarding their medical history, i.e. it was not possible to determine whether they were asymptomatic or had experienced severe headaches during life.

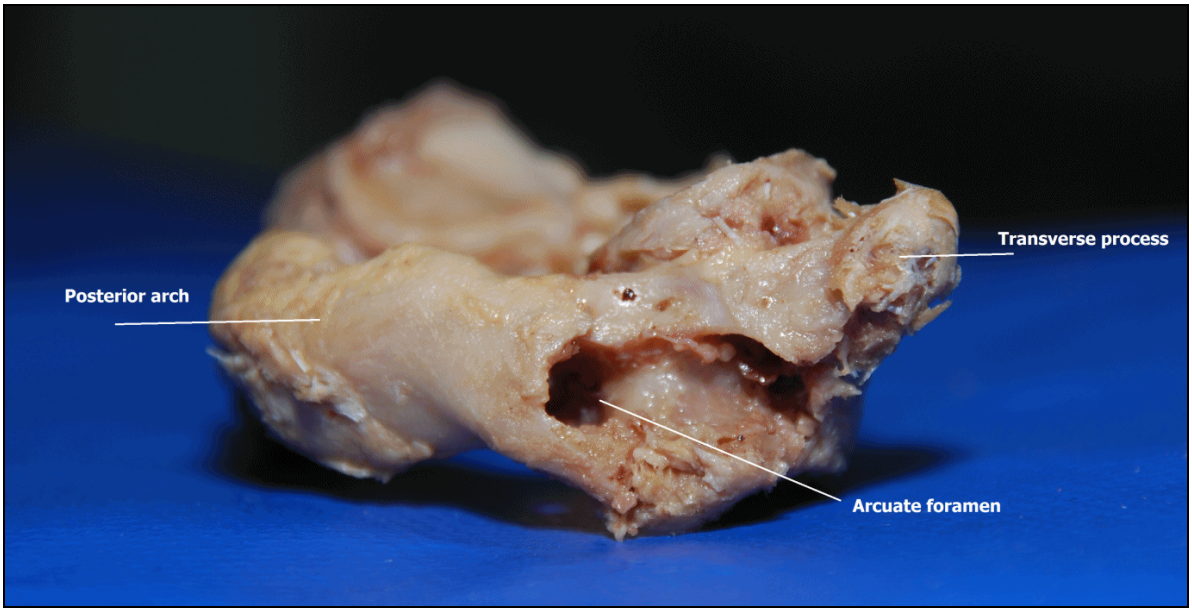

Figure 2 - Right lateral view of atlas showing the arcuate foramen.

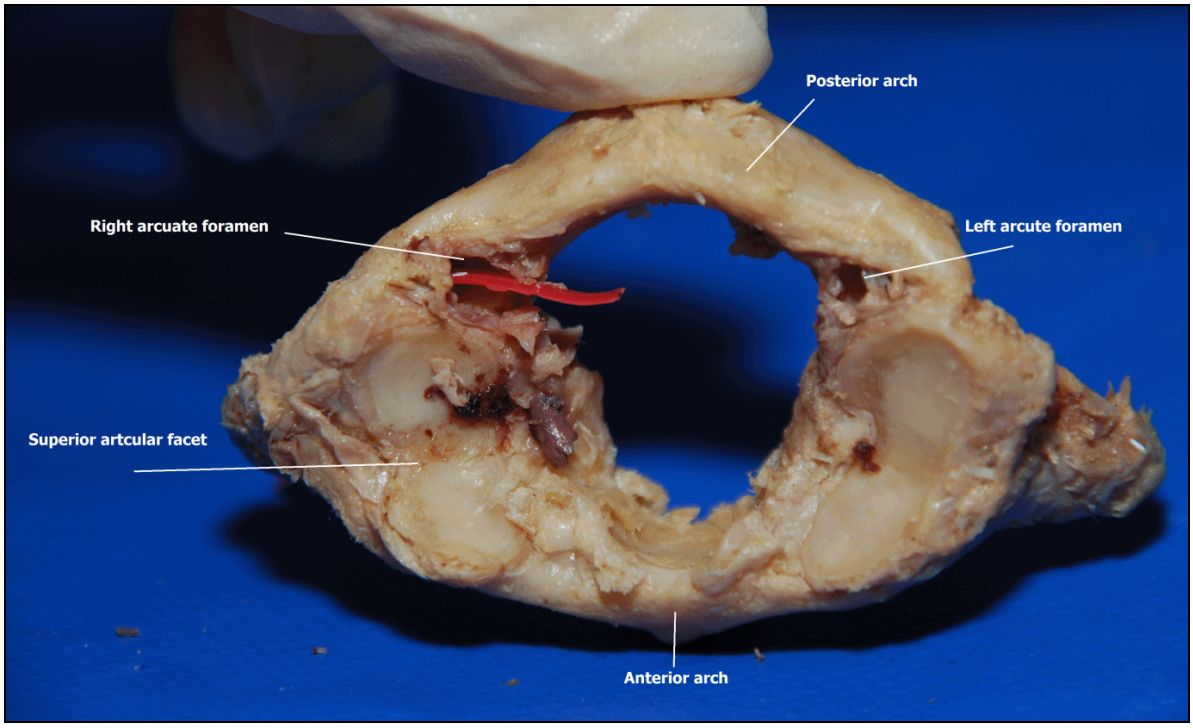

Figure 3 - Superior view of the atlas showing both arcuate foramina: the right foramen has a red marker passing through it.

DISCUSSION

The presence of an arcuate foramen of the atlas is variable and has been reported to have an incidence of 2.98% (Shinde and Malliksrjun, 2012) to 15.5% in the studied populations (Cushing et al, 2001; Young et al, 2005). The current study, albeit in a limited population of 10 cadavers, nevertheless has an incidence of accessory foramina of 15% (3/20 sides), similar to the incidence reported by Young et al (2005). Most previous studies have focused on the Indian population, with no previous study considering a Caucasian (Scottish) population. Some studies have reported a unilateral arcuate foramen (Nayak et al, 2005), while others report either complete bilateral (Nayak, 2008) or incomplete bilateral foramina (Shinde and Malliksrjun, 2012). In this study two specimens displayed bilateral arcuate foramina and one a unilateral arcuate foramen, all of which were type VI according to the Hasan et al (2001) classification.

An early report (Nayak, 1931) was of a 50 year old Indian male with complete fusion of the atlas and occipital bone anteriorly and of the posterior arch with the margin of the foramen magnum posteriorly, leaving two foramina on each side of the atlas for the passage of the 3rd part of the vertebral artery and the exit of the 1st cervical spinal nerve. In a recent study of 67 specimens Shinde and Mallikarjun (2012) reported two cases of accessory foramina associated with the posterior arch of the atlas; the first case being a complete right and an incomplete left foramen, and the second case being a complete left and an incomplete right foramen. The foramina were rounded with a diameter of 4-5 mm and were located as far as 3mm from the root of the posterior arch of the atlas. Nayak et al (2005) had also reported an arcuate foramen on the posterior arch of the atlas with complete fusion between the lateral masses and occipital condyles. According to Nayak (2007) the transverse foramen was absent on each side of the atlas. The transverse processes were comparatively long, being similar to those of thoracic vertebrae; however there was a groove present for the vertebral artery. The abnormal appearance of the transverse processes may be of clinical significance as they are important landmarks for surgeons and radiologists in locating anatomical structures. Bilateral asymmetrical foramen on the lateral aspect of the posterior arch of the atlas, with the right side foramen being double the size of that on the left have been reported by Nayak (2008): a vertebral artery groove was present and the transverse foramen were normal. Prakash et al (2010) observed a left side canal for the 3rd part of the vertebral artery formed by an osseous bridge connecting the posterior aspect of the superior articular process and the posterior arch of the atlas.

Depending on the severity of the posterior arch anomaly, tethering of the vertebral artery can occur as it passes through the additional canal leading to potential posterior circulation stroke (Cushing et al, 2001). Patients with a Kimmerle anomaly may experience neurovascular symptoms, including headaches in 83.3% of cases (Split and Sawrasewicz-Rybak, 2002). Koutsouraki et al (2010) are more specific suggesting that tension-type headaches and neurosensory-type hearing loss both have a strong link with a Kimmerle's anomaly.

A further anomaly which has been reported in relation to the atlas is non-fusion, in which the atlas consisted of three segments; a left lateral mass with part of the posterior arch, a right lateral mass, and finally the majority of the posterior arch: the anterior arch was absent (Dwight, 1887). According to Gehweiler et al (1983) in 36 cases of malformation of the atlas 16 demonstrated aplasia of the posterior arch and 20 showed atlas arch cleft. More recently De Zoete and Langeveld (2007) reported the case of a 42 year old female with congenital dysplasia of the anterior arch of the atlas. However, Smit et al (2013) has reported the case of a 21 year old male with an absent posterior arch of the atlas with no neuromuscular manifestations.

Absence of the anterior or posterior arch can occur as well as malformation of the atlantoaxial lateral offset and should not be confused with a Jefferson fracture if it is 2 mm or less (Gehweiler et al, 1983; De Zoete and Langeveld, 2007; Smit et al, 2013). In the present study the median atlantoaxial joint and both anterior and posterior arches appeared to be normal. Absence of a transverse foramen of the atlas is a very rare anomaly: bilateral absence has been reported by Nayak (2007). In the present study both were present and appeared normal.

In patients with arcuate foramina associated with the posterior arch of the atlas who undergo cervical spine fixation, lateral mass screw fixation of the atlas is contraindicated in order to avoid damage to the vertebral artery, as this may lead to stroke and then death. A preoperative cervical radiograph is therefore recommended (Huang and Glaser, 2003). The importance of this study is that it alerts surgeons to the potential complications associated with misdiagnosis. Furthermore, from a radiographic perspective, these atypical foramina can be confused with fractures of the atlas. Knowledge of variations

and anomalies associated with the atlas are important for surgeons, radiologists and physiotherapists. In individuals who suffer from chronic headache and/or some neurological symptoms, a Kimmerle anomaly should be considered.

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