Arcuate Foramen Family Study Series

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Abstract

INTRODUCTION

The arcuate foramen (AF) or posterior bridge anomaly of the atlas (C1) has been observed since the 19th century. Questions regarding its significance in anthropology, osteology, physiology, symptomatology, and clinical practice continue. This series presents data that supports the hypothesis that there is an inherited component to arcuate foramen.

METHODS

Lateral cervical radiographs were acquired of patients of upper cervical chiropractic. We noted the presence of AF in each radiograph and charted this information in family groups. This study series consists of two families, A and B, of three generations, and one unrelated set of identical twins, “R” and “H.”

RESULTS

One father in the 1st generation, family A, had a partial AF. Second generation siblings exhibited partial (male) and complete AF (female). The third generation from the complete female AF exhibited one complete and two partial AF, all male. The third generation from the partial male AF exhibited one female partial AF and one male with no AF.

Both identical twins show a partial AF, “R” showing bilateral partial and “H” unilateral partial.

DISCUSSION

Inherited etiology was first observed in 1955, and this is the first since then to examine three generations and identical twins. AF and other midline anomalies have been proposed to be related to neural crest cells and/or homeobox or hox genes. Micro-CT scan of AF specimens reveal thicker cortical bone structure than those without AF.

CONCLUSION

This series supports the hypothesis that there is genetic etiology of the AF. The significance of AF in triggering symptoms apart from vertebral subluxation has yet to be determined.

INTRODUCTION

First noted in the 19th century, the arcuate foramen (AF) has attracted scrutiny from several disciplines. Earliest attempts to understand its significance came from those seeking evidence of ranking within the species (1,2). With Adolph Kimmerle’s first-ever radiograph of AF in a living subject, interest grew (3). By 1955, a clear and testable hypothesis had emerged regarding a genetic component (4). This series presents data that supports the hypothesis that there is a genetic component to arcuate foramen and is the first to examine three related generations.

METHODS

All patients in our chiropractic office were first screened to establish the presence or absence of vertebral subluxation of the cranio-vertebral junction. In the natural course of this type of care, radiographs were taken of the cervical spine to develop a complete understanding of the history and quality of spine health and to develop a correction strategy to reduce the misalignment (5). The lateral cervical radiograph is captured first. AF presence is noted as present or absent to be aware of its potential influence on patient outcomes. Often, entire families are referred for care and the

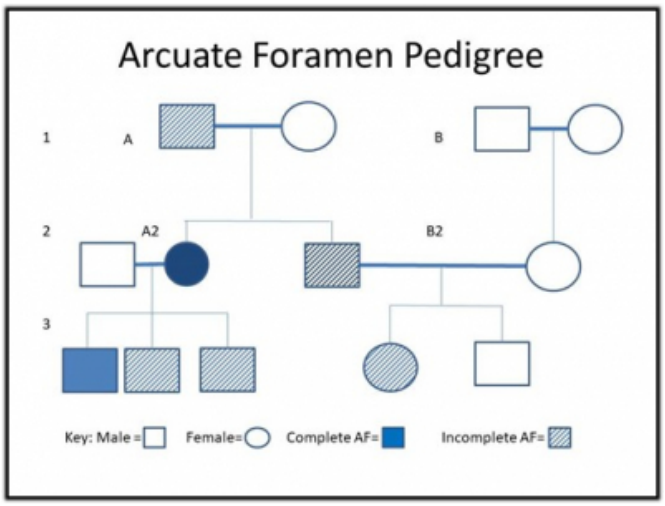
opportunity arises to study inherited traits. This study series consists of two families of three generations, and one set of identical twins, “R” and “H.”

RESULTS

The first generation of two families, A and B, reveals that the husband in family A has partial AF. Family B has no AF. The second generation daughter of family A with the complete AF married a man with no AF, forming family A2. The second generation son of family A with the partial AF married the daughter (no AF) of family “B”, forming family B2.

In the third generation, the offspring of A2 consist of three males, one with a complete AF and two with incomplete AF. The offspring of B2 consist of a female with AF and a male without AF (Figure 1).

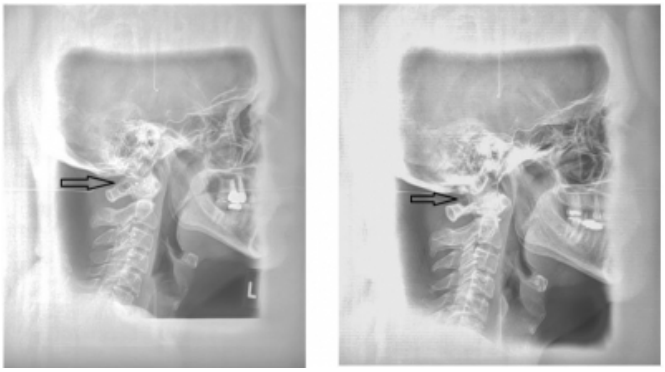
Figure 1



The set of identical twins reveal a complete bilateral AF in “R” and an incomplete unilateral AF in “H” (Figure 2).

Figure 2

Identical twins: “R” is on the left, “H” is on the right.



DISCUSSION

Proposed hypotheses made about etiology of the AF include the following:

- AF develops from an ossification center in the atlanto-occipital ligament (6)
- AF develops as an expression of degenerative changes (7)
- AF is a remnant of the proatlas (8-10)
- AF is a recessive genetic anomaly that is vanishing from the species (1,11)

Hypotheses made about clinical significance of AF include the following:

- AF causes migraines and other headaches (12-14)
- AF causes Autonomic symptoms such as vertigo and vasomotor disorders of the face, neck and upper extremities(15,16)
- AF causes neck and radicular pain (17,18)
- AF interferes with vertebral artery flow (12,19)
- AF can be associated with vascular lesions in posterior fossa of the skull (20)

Wight points out only anecdotal evidence in alleviation of headaches through chiropractic (14). However, Woodfield presents data drawing a connection between migraine, abnormal VA flow and the craniocervical misalignment (21). His paper supports the hypothesis that etiology of migraine can begin with misalignment of the upper cervical spine. The hypothesis that AF interferes with vertebral artery flow has been tested and is not supported (7). This paper fails to support the assertion that AF is a recessive and vanishing trait, and supports the hypothesis that there is a genetic component (11,22). Others have noted a relation between AF and other midline anomalies such as palatally displaced canines, bridging of the sella turcica, and Nevoid Basal cell carcinoma syndrome (23-25). Micro CT studies of AF reveal thicker cortical bone structure of the bridge, leading to the assumption that AF presence renders the atlas less susceptible to fracture (26). Genetic characteristics of AF and other midline anomalies have been proposed as possibly related to neural crest cells and/or homeobox or hox genes (23).

The data presented points to a non-sex-linked genetic trait. Future studies should investigate the array of symptoms displayed by individuals with AF and investigate its relationship with vertebral subluxation. The traditional role of the chiropractor is to correct the vertebral subluxation, and the traditional role of the upper cervical chiropractor is to correct a vertebral subluxation at the cranio-cervical junction (27). If the subluxated upper cervical spine is truly the element acting to produce symptoms such as vertigo,

headache and other vegetative symptoms, further research should explore the difference between AF effect and cranio-cervical subluxation effect. Is AF the element causing symptoms or is the vertebral subluxation causing symptoms? This question has not yet been addressed in the literature.

CONCLUSION

This series supports evidence of genetic etiology of the AF. Significance of AF in triggering symptoms apart from vertebral subluxation has yet to be determined.

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