Persistent proatlantal artery

N. A. HUTCHINSON AND J. D. R. MILLER

*From the Division of Neurology and the Department of Radiology,
University of Alberta Hospital, Edmonton, Alberta*

SUMMARY A case of persistent proatlantal artery is described and the developmental anatomy reviewed. This vessel, arising from the internal carotid artery in the neck, is liable to be confused with the hypoglossal artery, but unlike the latter it forms the vertebral artery outside the skull and enters through the foramen magnum.

The persistent proatlantal artery (Padget, 1954) is a rarely described member of the family of carotico-basilar anastomoses. In common with the trigeminal, otic, and hypoglossal arteries, it represents the failure of involution of embryonic vascular channels, the usefulness of which should have ended by the 12 to 14 mm (crown-rump length) stage of development. It originates from the internal carotid artery, executes a dorsalward curve (convex superiorly), and courses between the atlas and occiput to join the stem of the basilar artery.

The origins of the hindbrain circulation have been authoritatively demonstrated by Congdon (1922) and Padget (1948). Two 'longitudinal neural arteries' arise, ventral to the developing hindbrain and on either side of the mid line, as successors to the primitive hindbrain channel. Eventual fusion of these longitudinal arteries produces the basilar artery.

The internal carotid artery feeds the posterior circulation, first by a terminal caudal branch and shortly afterwards by the primitive trigeminal, otic, hypoglossal, and proatlantal arteries. However, by the 4 to 5 mm stage in the human embryo the primitive otic and hypoglossal arteries, while still contributing, are subordinate in importance to the trigeminal and proatlantal arteries, supplying the cranial and caudal portions of the brain-stem respectively.

The primitive otic artery is normally the first of these to regress. The development soon afterwards of the posterior communicating artery renders the trigeminal artery redundant; the involution of the latter, in Padget's stage III (7 to 12 mm embryo) (Congdon, 1922) is usually preceded by that of the hypoglossal artery.

The next step is the assumption by the vertebral arteries, developing meanwhile by longitudinal

anastomoses between the transversely-running cervical intersegmental arteries, of the caudal vascular supply to the hindbrain. The vertebral artery on each side accomplishes this by incorporation of the proatlantal artery, the latter henceforth representing the transversely directed portion of the vertebral trunk between the upper border of the first cervical transverse process and the occipital bone. Persistence of the proatlantal artery results in the basilar artery being supplied (on the affected side) by the internal carotid artery.

CASE REPORT

CLINICAL HISTORY M.C., a 53-year-old male, was admitted on 13 March 1969 to the Neurosurgical Service of the University of Alberta Hospital, under Dr. P. B. R. Allen, with post-traumatic headache of three weeks' duration.

Neurological examination revealed some intellectual sluggishness, mild papilloedema, increased deep tendon reflexes in the left limbs, and an extensor plantar response on the same side.

NEURORADIOLOGICAL INVESTIGATIONS Plain films of the skull showed a linear fracture in the right frontotemporal region. Bilateral carotid angiography was performed under local anaesthesia. On the right side, the proximal few centimetres of internal carotid artery showed a slight fusiform dilatation, tapering fairly abruptly (Fig. 1). In the AP view the findings were those of an acute or sub-acute subdural haematoma (Fig. 2). This was subsequently evacuated, the patient making a good recovery.

On the left side 1 cm distal to its origin the internal carotid artery bifurcated at the C3 level, giving off a large branch extending posteriorly and medially to form the upper end of the vertebral artery, above the transverse process of C1 (Fig. 3). The vertebral artery followed a normal course distally, entering the skull through the

FIG. 1. (Left). Right carotid angiogram, lateral projection, showing the step-like decrease in diameter of the internal carotid artery at the level of the 2nd cervical vertebra. FIG. 2. (Right). Right carotid angiogram, anteroposterior projection showing the peripheral branches of the middle cerebral artery displaced from the inner table of the skull by the acute subdural haematoma, and the 'square shift' of the pericallosal artery to the left of the midline.

FIG. 3. (a), (b), and (c). Left carotid angiogram, lateral projection showing the large calibre internal carotid artery (1); the large persistent proatlantal artery (2) arising at the level of C2, and the distal internal carotid artery (3) which is of smaller diameter than the proatlantal artery.

foramen magnum and filling the basilar artery well, with no evidence of blood supply from the right vertebral artery (Fig. 4). The internal carotid artery distal to the bifurcation was smaller in calibre than the proatlantal artery; the left anterior and middle cerebral arteries were well demonstrated and showed a shift of the mid line vessels to the left.

FIG. 4. Left carotid angiogram, anteroposterior projection showing the proatlantal artery (2) terminating in the basilar artery, and the internal carotid artery (3).

DISCUSSION

Current experience suggests that the trigeminal artery persists into adult life more frequently than the hypoglossal, proatlantal or otic anastomoses.

The proatlantal artery is easily confused with the persistent hypoglossal artery, but the following criteria have been found helpful in distinguishing the two:

1. The proatlantal artery enters the skull *via* the foramen magnum, the appearance of the atlanto-occipital portion of the vessel differing in no way from that of the normal vertebral artery, since the origin is identical in each case.

The hypoglossal artery, on the other hand enters the skull through the anterior condyloid foramen. Its extra-cranial segment therefore takes a more vertical course and lacks the dorsal sweep of the persistent proatlantal artery.

2. The literature suggests that, as could be expected, the hypoglossal artery usually leaves the

internal carotid artery at a slightly higher level (opposite C1 or the C1/2 interspace) than the proatlantal artery, which leaves opposite the body of C2 or at the C2 interspace.

The absence of any demonstrable anastomosis with the cervical intersegmental arteries, coupled with the level of origin from the internal carotid artery, effectively distinguishes this artery from other examples of anomalous development of the vertebral artery (persistent cervical intersegmental arteries, aortic origin of the vertebral artery, etc.).

It is perhaps noteworthy that in some of Congdon's specimens a certain tardiness was noticed in the formation of the critical anastomosis between the proatlantal artery and the first cervical intersegmental arteries (first and second cervical segmentals by his terminology). It is therefore highly probable that the developmental error leading to the persistence of the proatlantal artery lies in an inadequate communication at this level.

Reported cases of persisting proatlantal artery are few: Abe and Suzuki (1964), Conforti, Armenise, and Galligioni (1966), and Lie (1968) have demonstrated it angiographically and Gottschau described the first case in 1885. Failure to identify this artery adequately may account partially for the rarity of reported cases.

In spite of the incomplete angiographic studies in this case, no vertebral arteriography having been performed, the findings suggest a high degree of dependence of the vertebrobasilar circulation on blood flow through the left internal carotid artery. The dangers inherent in such an arrangement are obvious and the evolutionary regression implies a primary error in the development of the vertebral artery on that side. This hypothesis is supported by the experience of others—for example, there appears to be a significant incidence of absent or vestigial vertebral arteries in association with persistent hypoglossal arteries (Abe and Suzuki, 1964).

The authors thank Mrs. V. Senko, who did the typing, the Photography Department for the photographs, and Dr. P. B. R. Allen for permission to use his case records.

REFERENCES

- Abe, K., and Suzuki, T. (1964). Persistence of embryonic carotid-vertebrobasilar anastomoses. *Folio psychiat. neurol. jap.*, **18**, 257-276.
- Congdon, E. D. (1922). Transformation of the aortic arch system during the development of the human embryo. *Contr. Embryol. Carneg. Instn*, **14**, 47-110.
- Conforti, P., Armenise, B., and Galligioni, F. (1966). Anomalous carotid-vertebral anastomosis, primitive cervical segmental artery. *Neurochirurgia (Stuttg.)*, **9**, 99-106.

- Gottschau, M. (1885). Zwei seltene Varietäten der Stämme des Aortenbogens. *Arch. Anat. Entwickl.-Gesch.*, 245-252. (Cited by Abe and Suzuki, 1964.)
- Lie, T. A. (1968). *Congenital Anomalies of the Carotid Arteries*. Excerpta Medica Foundation: Amsterdam.
- Padget, D. H. (1948). The development of the cranial arteries in the human embryo. *Contr. Embryol. Carneg. Inst.*, 32, 205-262.
- Padget, D. H. (1954). Designation of the embryonic intersegmental arteries in reference to the vertebral artery and the subclavian stem. *Anat. Rec.*, 119, 349-356.