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Persistent Carotid-Vertebrobasilar Anastomosis Radiologic Findings¹

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Purpose : To evaluate the radiologic findings of carotid-vertebrobasilar anastomosis and associated anomalies.

Materials and Methods : Thirteen patients with fourteen cases of carotid-vertebrobasilar anastomosis collected from January 1992 to December 1997 were reviewed. Clinical diagnosis referred for cerebral angiography were cerebral infarction (n=3), intracranial hemorrhage (n=2), subarachnoid hemorrhage (n=1), brain tumor (n=3), arteriovenous malformation (n=3) and trigeminal neuralgia (n=1). Cerebral angiograms and clinical symptoms were retrospectively analyzed.

Results : The fourteen carotid-vertebrobasilar anastomosis consisted of eleven cases of persistent trigeminal artery and three cases of type I proatlantal intersegmental artery. Persistent trigeminal arteries were associated with anterior communicating artery aneurysm(n=1), posterior fossa arteriovenous malformation(n=2) and persistent trigeminal artery variant(n=5). Type I proatlantal intersegmental arteries were associated with hypoplastic vertebral arteries(n=2): only proximal segment in one, and proximal and distal segments in one case. Only one patient had clinical symptom related to the carotid-vertebrobasilar anastomosis which was trigeminal neuralgia.

Conclusion : Knowledge of the anatomical and radiologic findings of carotid-vertebrobasilar anastomosis and associated anomalies will aid in the accurate diagnosis of neurovascular disease and prevent possible complications during surgical and interventional procedures.

Index words : Brain, anatomy
Brain, angiography
Cerebral blood vessels, abnormalities

There are four embryonic cerebral arteries that directly connect the carotid artery with vertebrobasilar arterial system. They are primitive trigeminal, otic (acoustic), hypoglossal, type I and type II proatlantal intersegmental artery(1). Uncommonly these carotid-vertebrobasilar anastomosis persist into adult life(Fig. 1). These anomalous vessels are also known to be frequently accompanied by aneurysms of the circle of Willis and other arteriovenous anomalies(2).

Therefore, awareness of these uncommon anomalies is important in clinical setting, especially for vascular intervention and neurovascular surgery. We present the radiologic findings of thirteen patients with fourteen carotid-vertebrobasilar anastomosis and associated vascular anomalies.

Materials and Method

We retrospectively analysed the angiographic and clinical manifestations of thirteen patients with fourteen carotid-vertebrobasilar anastomosis collected from January 1992 to December 1997. Twelve patients were found while performing 3552 consecutive cer-

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erebral angiographic studies and one patient was found in MR angiogram of the brain during the same duration. The patients consisted of five males and eight females with ages from 25 years to 68 years (mean 50 years).

Clinical diagnosis referred for cerebral angiography were cerebral infarction in 3 patients, intracranial hemorrhage in 2 patients, subarachnoid hemorrhage in 1 patient, brain tumor in 3 patients, arteriovenous malformations in 3 patients and trigeminal neuralgia in 1 patient.

Cerebral angiography was performed through percutaneous transfemoral catheterization by a neuroradiologist using digital subtraction angiography equipment. Both internal carotid artery and vertebral artery selective studies were performed in each patient with a 5 Fr catheter. Common carotid artery selective study was performed when required or in cases of severe atheromatous disease.

Angiographic findings of both internal carotid artery and vertebral artery studies were reviewed. In each case the type of carotid-basilar or carotid-vertebrobasilar anastomosis was determined by its origin from the internal carotid artery, anastomotic site to vertebrobasilar system and/or the territory of arterial supply. The clinical findings were reviewed using medical records for cranial nerve symptoms with possible relation to the carotid-vertebrobasilar anastomosis.

Results

Of the thirteen patients with fourteen carotid-vertebrobasilar anastomosis, twelve patients were found while performing 3552 cerebral angiograms with incidence of 0.34% (12/3552) and one patient was found on MR angiography of the brain. They were eleven patients with persistent trigeminal artery and two patients with three cases of type I proatlantal

intersegmental arteries. The incidence of persistent trigeminal artery found on conventional cerebral angiography was 0.28% (10/3552) when excluding the one case found on MR angiography.

Persistent trigeminal arteries originated from cavernous segment (C5) of left internal carotid artery in six cases and from right internal carotid artery in five cases. Associated anomalies were aneurysm of the circle of Willis (n=1), arteriovenous malformation (n=2), persistent trigeminal artery variant (n=5) and trigeminal neuralgia (n=1). Anterior communicating artery aneurysm was seen in one patient (Fig. 2) and posterior fossa arteriovenous malformation was seen in two patients. Persistent trigeminal artery was one of the feeding artery of a posterior fossa arteriovenous malformation in one patient (Fig. 3). Variant type of persistent trigeminal artery with communication to the cerebellar artery was seen in five patients with an inci-

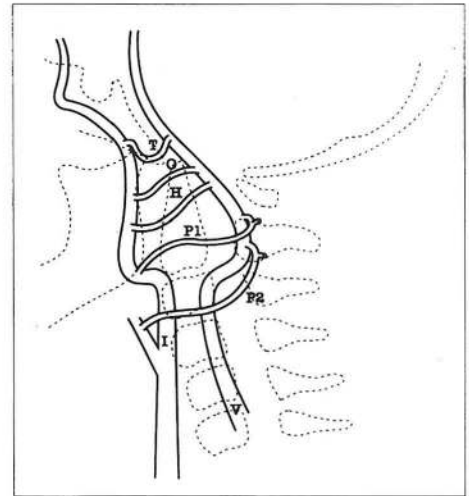
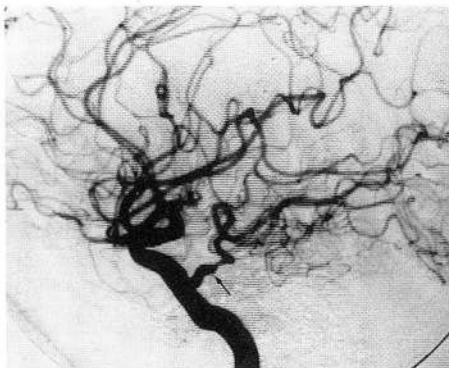
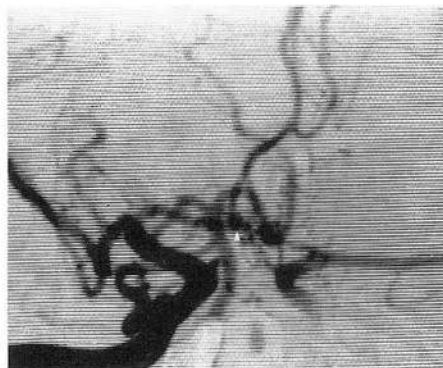


Fig. 1. Anatomic diagram illustrating embryonic carotid-vertebrobasilar anastomosis in lateral view. T, persistent trigeminal artery. O, persistent otic(acoustic) artery. H, persistent hypoglossal artery. P1, type I proatlantal artery. P2, type II proatlantal intersegmental artery. I, internal carotid artery. V, vertebral artery.



A



B

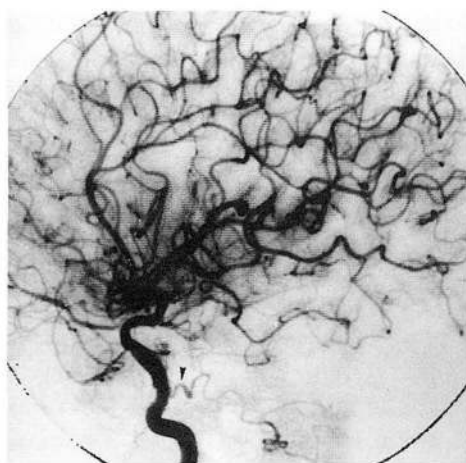
Fig. 2. A 56-year-old female with subarachnoid hemorrhage.

A. Lateral view of right internal carotid angiogram shows persistent trigeminal artery (arrow) anastomosing the cavernous internal carotid artery with basilar artery.

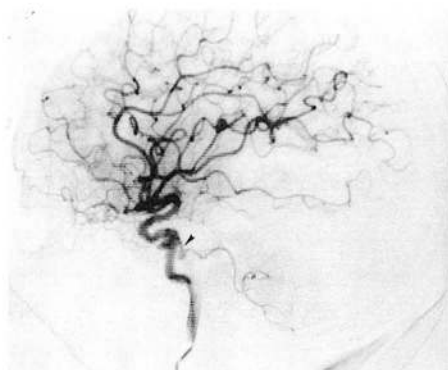
B. Right anterior oblique view of right internal carotid angiogram shows anterior communicating artery aneurysm (white arrow head).



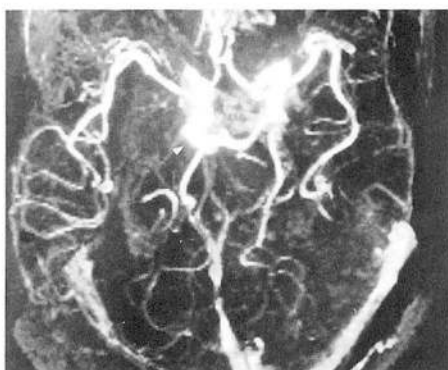
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4



5



6



A



B

Fig. 3. A 28-year-old male patient with dysarthria and left side weakness. Lateral view of left internal carotid angiogram shows persistent trigeminal artery (arrow) originating from the cavernous segment of left internal carotid artery supplying a large posterior fossa arteriovenous malformation.

Fig. 4. A 52-year-old male with right middle cerebral artery infarction. Lateral view of right carotid angiogram shows a variant persistent trigeminal artery (arrow head) from the cavernous segment of right internal carotid artery supplying right anterior inferior cerebellar artery.

Fig. 5. A 58-year-old male with intracranial hemorrhage. Lateral view of left internal carotid angiogram shows a variant persistent trigeminal artery (arrow head) from cavernous segment of left internal carotid artery supplying left posterior inferior cerebellar artery.

Fig. 6. MR angiography of a persistent trigeminal artery (white arrow head) connecting right internal carotid artery to basilar artery in a 60 year old female with trigeminal neuralgia.

Fig. 7. A 25-year-old female with facial arteriovenous malformation on glabella supplied from both external carotid arteries.

A. Lateral view of left internal carotid angiogram shows a type I proatlantal intersegmental artery (arrow) anastomosing the left internal carotid artery with distal left vertebral artery.

B. Lateral view of right internal carotid angiogram shows a proatlantal type origin of right posterior inferior cerebellar artery (arrow) from proximal right internal carotid artery.

dence of 0.14% (5/3552). They communicated to the anterior inferior cerebellar artery in four patients (Fig. 4) and communicated to the posterior inferior cerebellar artery in one patient (Fig. 5). Persistent trigeminal artery was associated with trigeminal neuralgia in one patient (Fig. 6)

All three cases of proatlantal intersegmental arteries were type I and originated from proximal internal ca-

rotid artery. Two of these three cases occurred bilaterally in one patient who had facial arteriovenous malformation. Proatlantal intersegmental artery on the right side was connected with the posterior inferior cerebellar artery and the one on the left side with distal vertebral artery. Both proximal and right distal vertebral arteries were hypoplastic in this patient (Fig. 7).

One patient had trigeminal neuralgia related to per-

sistent trigeminal artery. Other patients had no cranial nerve symptoms which might be related to carotid-vertebrobasilar anastomosis.

Discussion

Embryologic sequence of events of cranial arteries during development was extensively reviewed by Padget(3, 4). Persistent carotid-vertebrobasilar anastomosis are uncommon anomalies of arterial connection between the carotid and vertebrobasilar circulation which represent persistence of various anastomotic channels between primitive internal carotid artery and longitudinal neural system. In order of decreasing frequencies, they are persistent trigeminal artery, persistent hypoglossal artery, persistent otic(acoustic) artery, type I and type II proatlantal intersegmental arteries. Except for the proatlantal intersegmental arteries, they are named according to the cranial nerves which they parallel(5).

Persistent trigeminal artery is the most frequently encountered persistent carotid-vertebrobasilar anastomosis. Since the first demonstration by angiography in 1950(6), angiographic reports have far outnumbered the anatomic report with incidence of 0.1 to 0.6 % (7, 8). In a review of 134 persistent trigeminal arteries described prior to 1964, no sex or side(left or right) predominance could be found(9). The incidence of persistent trigeminal artery in our study was 0.28 % which approximated previous report by Lie(7). We could not find any side predominance and although the results showed a greater proportion of female, the series is too small to make any definite conclusion regarding sex predominance.

Persistent trigeminal artery has been associated with other anomalies of intracranial vessels. Asymmetry of the circle of Willis with aplasia or hypoplasia of the posterior communicating artery, aneurysms of the circle of Willis and aneurysms of the trigeminal artery itself has been reported. These aneurysms are suggested to arise from structural defects at site of involution of embryonic vessels(8, 10, 11).

Arteriovenous malformations accompanying persistent trigeminal arteries are also reported although it is not certain whether true increase in incidence is present(2, 12). Previously reported arteriovenous malformations had no direct communication with the trigeminal arteries. In posterior fossa arteriovenous malformations, however, the trigeminal artery can be a feeding artery which may have influence on selecting the mode of treatment.

The persistent trigeminal artery variant represents

an anomalous origin of the superior or inferior cerebellar artery from internal carotid artery with an incidence of 0.18 % (2, 13, 14). They are suggested to result from persistence of a primitive trigeminal artery associated with an incomplete fusion of the longitudinal neural plexi. Since the primitive trigeminal artery is closer to the origin of the anterior inferior cerebellar artery, this vessel is more likely to originate from the carotid artery(15, 16). Variations of origin of the posterior inferior cerebellar artery from a persistent hypoglossal artery, proatlantal artery, posterior meningeal artery and intracranial segment of internal carotid artery has been reported(17). Excluding the posterior inferior cerebellar artery originating from the proatlantal artery, the incidence of variant cerebellar arteries from internal carotid artery was 0.14 % in our study.

Clinical symptoms directly related to the persistent trigeminal artery could not be found and was postulated as incidental findings in previous reports(8, 9). Also in our reported cases, except for one trigeminal neuralgia associated with persistent trigeminal arteries, no directly related symptoms could be found.

The persistent proatlantal intersegmental artery originates from the posterior side of the internal carotid artery and courses upward and dorsolaterally to the horizontal segment of the vertebral artery. The proximal segment of the vertebral artery is usually hypoplastic(18). As stated with persistent trigeminal artery variant, anomalous origin of the posterior inferior cerebellar artery may also arise from persistent proatlantal intersegmental artery.

Although persistent carotid-vertebrobasilar anastomosis are rare anomalies, they can present with various associated anomalies and radiologic findings. Knowledge of its radiologic findings and possible associated anomalies will be required for accurate diagnosis of neurovascular disease and in prevention of possible complications in interventional and surgical management.

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경동맥 척추기저동맥계 문합: 방사선학적 소견에 대한 고찰¹

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목 적: 선천성 혈관계 이상인 경동맥-척추기저동맥계 문합(carotid-vertebrobasilar anastomosis)의 방사선학적 소견과 이에 동반된 이상소견을 알아보고자 하였다.

대상 및 방법: 1992년 1월부터 1997년 12월까지 시행한 고식적 뇌혈관 조영술 및 자기공명 뇌혈관 조영술을 통하여 13명의 환자에서 발견한 14예의 경동맥-척추기저동맥계 문합을 대상으로 하였다. 뇌혈관 조영술을 시행한 원인으로서는 뇌경색증(3명), 뇌출혈(2명), 뇌지주막하 출혈(1명), 뇌종양(3명), 동정맥기형(3명), 삼차신경통(1명)이었다. 이들의 뇌혈관 조영술 소견과 임상 증상을 후향적으로 분석하였다.

결 과: 14예의 경동맥-기저동맥계 문합은 삼차신경동맥 존속증이 11예, 제1형 환추전동맥 존속증이 3예였다. 삼차신경동맥 존속증에 동반된 이상으로 1예에서 전교통 동맥류가, 2예에서 동정맥 기형이, 5예에서는 삼차신경동맥과 소뇌동맥의 연결이 발견되었다. 제1형 환추전동맥 존속증에 동반된 이상으로는 1예에서 근위부 척추동맥의 형성 부전이, 또 1예에서는 근위부 및 원위부 척추동맥의 형성 부전이 동반되었다. 경동맥 추골뇌저동맥계 문합으로 인한 임상증상이 있었던 예는 1예로서 삼차신경통이 유발된 예였다.

결 론: 경동맥 척추기저동맥계 문합과 이에 동반될 수 있는 혈관 이상의 해부학적 및 방사선학적 소견을 아는 것은 뇌혈관 질환의 정확한 진단과 수술 및 혈관중재적 시술에서 초래될 수 있는 합병증을 예방하는데 중요하다.

1999년도 대한방사선의학회 중요행사 일정 안내 (Ⅲ)

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	연수교육	99. 10. 3(일)	인촌기념관
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	Subspecialty Imaging Conference	99. 9. 15(수)	
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