Variant anatomy of superior cerebellar artery and associated clinical implications

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ABSTRACT

Superior cerebellar arteries originate from basilar artery just before terminating into posterior cerebral arteries. These arteries travel below the 3rd and above the 4th cranial nerves. Superior cerebellar arteries (SCA) irrigates superior surface of cerebellum and superior vermis. The knowledge of variations in the branching pattern of SCA is essential to neuro-radiologists and neurosurgeons in comprehending vascular malformations, SCA syndrome, handling of lesions of the basilar termination and explaining trigeminal neuralgia. The variations are also valuable to avoid inadvertent ligation or sectioning of these arteries during surgical approaches to the posterior cranial fossa lesions. Due to afore mentioned immense clinical implications of these arteries, review of literature has been explored. The study will provide ready and consolidated information for radiologists for interpretation of imagery and neurologists for diagnosing and treating lesions around the superior cerebellar arteries

Key Words: *Basilar artery; Superior cerebellar artery; Cerebellum*

INTRODUCTION

The superior cerebellar artery (SCA) normally originates from the basilar artery (BA) just before its termination into posterior cerebral arteries (Figure 1). SCA travels posteriorly around the midbrain to supply the superior surface of cerebellar hemispheres and superior vermis (1). The main stem of the SCA arises from the BA and courses along the pontomesencephalic fissure below the occulomotor nerve and then curves posteriorly through the cerebellomesencephalic fissure up to the anterior edge of the tentorial surface (2).

During this course, SCA divides mostly at the lateral pontomesencephalic level. These branches are given different names such as rostral and caudal (2), superior and inferior (3) and lateral and medial branches (4). The rostral trunk irrigates the vermis with adjacent cerebellar hemisphere whereas the caudal trunk supplies the more lateral cerebellar hemisphere, such as the superior part of the petrosal surface.

A number of variations of SCA have been reported. Variations and anomalies in the branching pattern of SCA are essential to radiologists and neurosurgeons to comprehend vascular malformations, SCA syndrome, lesions of the basilar artery, trigeminal neuralgia and variant termination of the basilar artery, better (5-8). Besides, information are of immense value to avoid inadvertent ligation or sectioning of these arteries during surgical approaches to the posterior cranial fossa for different clinical conditions such as aneurysms, arteriovenous malformations, tumors, epilepsy surgery, posterior temporal lobectomies and posterior cerebral revascularization (9-11). Posterior cranial fossa tumors constitute 54%-70% of childhood and 15%-20% of adult brain tumors (12). Posterior circulatory stroke accounts for 10%-15% of all strokes (13). The variant origin is important during interpretation of radiographs to avoid incorrect diagnosis, explaining unusual presentation of posterior circulatory stroke, possible implications of surgery and interventional procedures (14,15). The occurrence of aneurysms, atherosclerosis and posterior circulatory stroke may also be affected by variant anomalies related to SCA (16).

Review of literature has been carried out to consolidate and update the knowledge in relation to variations in the branching pattern of SCA.

MATERIALS AND METHODS

The study was carried out in the department of anatomy, AIIMS Rishikesh. The literature search was done using following data bases for updating knowledge related to superior cerebellar artery-sceilo, medline, scopmed, pubmed, wiley online library and research gate. Only English language articles and selected reference text books were taken into account. Papers containing original data were selected and secondary references retrieved from bibliographies. Search terms used for surfing the literature were as follows- anomalies of SCA, Agenesis of SCA, and duplication of SCA, triplication and fenestration of SCA, clinical implications of variations of SCA. Literature search was done for updating present and past research work carried out by researchers and consolidating it for ready references for future researchers and clinicians.

RESULTS AND DISCUSSION

Branching pattern of SCA can be studied under following headings-Agenesis, duplication, trifurcation, and hypoplasia, abnormal origin from posterior cerebral artery, fenestration and formation of common trunk.

The agenesis of SCA is not reported in literature either in one side or both sides. SCA was detected by Hardy et al. (17) in all 25 brain specimens which he observed. 43 SCAs arose as a single trunk, and 7 arose as duplicate trunks. One solitary trunk and the rostral trunk of one duplicate vessel arose anomalously from the posterior cerebral artery in place of basilar artery. The remaining SCAs arose from the basilar artery. Hardy et al. (17) divided SCA into four segments: the anterior pontomesencephalic segment lying below the oculomotor nerve; the lateral pontomesencephalic segment course below the trochlear and above the trigeminal nerve; the cerebellomesencephalic segment coursed in the groove between the cerebellum and the upper brain stem; and the cortical segment was distributed to the cerebellar surface (17).

Uchino et al. (9) observed variations of SCA on MR angiograms. He reviewed 145 MR angiograms and found 16 duplicated SCAs in 13 patients, 7 SCAs originating from the posterior cerebral arteries (PCA) in six patients, four early bifurcations of the SCAs in four patients, and one SCA arising from the internal carotid artery. Uchino et al. (9) are of view that most of these SCA variations have low clinical significance but preoperative identification of SCA variations is important for avoiding complications during surgery and/or for interventional procedures of the distal basilar artery.

SCA arising bilaterally from the posterolateral aspect of PCA has been observed (9,18,19). Origin of the SCA from the PCA was found in 1.9%, 4%, 2.6% and 25.3% of cases examined by various authors (8,9,20,21). Pai et al.

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(10) detected duplicate SCA from BA on right side in eight specimens out of total 50. Pai et al. observed the SCA arising from the P1 segment of PCA in one case. The SCA may be difficult to recognize during surgery and it is mostly identified by presence of the third cranial nerve (19).

Different variations of the SCA including duplication, triplication and its origin from the PCA have been reported previously out of which duplication of the SCA was found in 28% (22), 14% (17), 20% (23), 5.9% (9), and 25% (24), 21.3% (25) of cases. Triplication was also noted in 2% (8,17) and 8% (26) of cases. Bilateral duplication is another variation occurring in 2% cases (9,17). Early bifurcation, fenestration and hypoplastic SCA were noted in 8%, 0.7% and 0.7% of the cases respectively. SCA with diameter of <1 mm was considered to be hypoplastic. The length of the SCA from its origin to its bifurcation into rostral and caudal branches ranged from 6-23 mm (8).

Aneurysms and stroke are the most common form of cerebrovascular diseases affecting mankind with a high degree of morbidity and mortality. The presence of arterial variations in SCA can be one of the factors attributed to aneurysms and thrombus formation leading to cerebellar infarcts (8). Infarcts in the superior cerebellar artery irrigation territory are most commonly diagnosed clinically, radiologically and in post-mortem culminating into limb ataxia along with dysarthria, ataxia, vertigo and vomiting (27). SCA infarcts may produce mass effect and obstructive hydrocephalus. Most of these clinical conditions are accompanied by lesions in neighbouring regions such as the midbrain, the thalamus and irrigation areas of the posterior cerebral artery in 75% of cases (28). Lesion in the SCA may also cause neurobehavioral syndrome, called cerebellar cognitive affective syndrome, characterized by spatial cognitive deficits, visual memory, language, personality and behavioural changes.

The proximal segment of SCA is a potential bypass site for reconstructive and revascularization surgeries for vertebrobasilar insufficiencies (29). The origin of SCA lies within the interpeduncular cistern and the oculomotor nerve is located between SCA and PCA. From its origin the artery curves encircling the brainstem and passes below the trochlear nerve and above the trigeminal nerve (Figure 1). The variations of the course of SCA can alter its relationship with oculomotor, trochlear and trigeminal nerves resulting in compression symptoms (30).

The artery is divided into prepontine segment, ambient segment, quadrigeminal segment and cortical segments (8). The SCA is intimately related to the III, IV and V cranial nerves (Figure 1). Anatomical variations of SCA may therefore present with palsies of these nerves. Tortuous and elongated SCA can compress the trigeminal nerve resulting in trigeminal neuralgia. Microvascular decompression procedure by wrapping technique is the latest treatment used for trigeminal neuralgia (30).

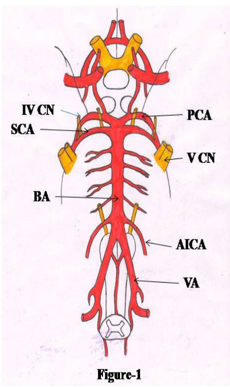

Figure 1) *Showing normal disposition of superior cerebellar artery and its relation with 3rd, 4th and 5th cranial nerves. VA- vertebral artery, AICA- anterior inferior cerebellar artery, BA- basilar artery, V CN- fifth cranial nerve, PCA- posterior cerebral artery, SCA- superior cerebellar artery, IV CN- fourth cranial nerve.*

The position of the SCA in the perimesencephalic cisternis a sensitive indicator of tumours located either intrinsic or extrinsic to the midbrain as this segment of the SCA may be displaced medially, posteriorly, anteriorly, or laterally by the avascular masses, meningiomas, aneurysms, arteriovenous malformations, atheromatous disease, or vascular neoplasms. Large extra-axial masses arising from the clivus or the cerebellopontine angle can impinge upon the anterior aspect of the midbrain and displace the first segment of the SCA towards the midline (31) creating various clinical complications.

The BA bifurcation is an important determinant of the initial course of SCA. In the 5-8 mm embryo the BA is formed by the fusion of the longitudinal neural arteries. Lack of normal fusion at the origin of the SCA, during development of the BA from the neural arteries and the PCA which connects the carotids and primitive neural arteries, anastomose with the BA caudally at a point lower than the normal site. These two ontogenetic interpretations explain the variations of the SCA (18).

The revascularisation procedures use rostral or caudal trunks of the SCA. The easy access to these trunks is made through a combined petrosal, lateral supracerebellar-infratentorial, or sub-temporal approach. The rostral branch of the SCA is largest trunk having more perforating branches than the main SCA. Caudal trunk, marginal branch and the rostral trunk are more closely related to IV cranial nerve. Thus when the rostral trunk is used for revascularization, there is an increased chance of injury to IV cranial nerve and perforator infarcts (32) leading to ischemia/infarcts in the territory irrigated by perforators and IV cranial nerve dysfunction.

The superior cerebellar artery, an arteriographic landmark to diagnose posterior fossa lesions is important because of its position relative to the upper brain stem and superior cerebellum for the assessment of lesions in and adjacent to these areas. The anatomical variations of the vertebrobasilar system and its branches are of immense use to precisely interpretthe ischemic areas and to diagnose lesions during endovascular interventions and posterior cranial fossa surgeries (32).

Arterial bypass procedure can be used in the treatment of vertebrobasilar ischemia, basilar artery stenosis, skull base tumors, and arterio-venous malformation related to posterior circulation. In this procedure PICAs, AICAs, SCAs, or PCAs are anastomosed end-to-end, end-to-side, or side-to-side to the contralateral equivalent arteries or to the extra cranial arteries such as superficial temporal artery and the occipital artery to carry out the revascularization of the neural parenchyma. Large basilar apex aneurysms are treated by double-barrel anastomoses of the superficial temporal artery to the superior cerebellar artery (33). The cerebrovascular anatomical variations, interarterial anastomoses, and the haemodynamic situation are the major factors that detect the location and extent of the infarcts. The cause of these infacts may be embolism or thrombosis in SCA (8).

Variations in origins, diameters, irrigation areas, and anastomoses of the arteries may result into different clinical findings in different cases on interpreting the cause and the outcome of the ischemic events. The unfamiliarity with the common variations of the SCA may lead to misinterpretation and mismanagement of diseases related to SCA (2,24,34,35). Thus the detailed knowledge of variations in SCA and associated clinical implications are of utmost use to radiologists and neurosurgeons.

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