INTRODUCTION

The brainstem is located in the posterior fossa which connects the brain and spinal cord. It consists of midbrain, pons, and medulla oblongata craniocaudally[1]. Their primary functions are regulating cardiac and respiratory activities. It also contains nuclei of III to XII cranial nerves. Brainstem syndromes are mostly due to vascular causes involving the posterior circulation. They have varied clinical presentations. Hence, knowledge of functional anatomy and clinical features helps in early diagnosis and management.[2]

MATERIALS AND METHODS

MRI was performed using 1.5T Siemens with T1, T2, FLAIR, and DWI sequences in the axial plane MRI of patients who were referred as posterior circulation stroke were reviewed and 45 cases were selected in which the abnormal findings on MR correspond to a particular vascular distribution. The MR findings were then correlated with the patient’s clinical symptoms.

RESULTS

- Out of 45 patients, 31 patients were male (68.9%) and 14 patients were female (31.1%).
- The mean age of the study group was 52.5 yrs ranging from 40 to 68 yrs
- Midbrain is involved in 8/45 patients (17.8%)
- Pons is involved in 20/45 patients (44.4%)
- Medulla is involved in 17/45 patients (37.8%)
- The side of involvement among the study participants (left and right side) was almost equally distributed
- DWI is extraordinarily sensitive in detecting acute infarcts.
- Syndromes involving the medial side of the brainstem have contralateral hemiplegia and ipsilateral cranial nerve palsy.
- Syndromes involving the lateral side of the brainstem have a contralateral loss of pain and temperature senses and ipsilateral Horner’s syndrome.

Midbrain Anatomy

The midbrain has a ventral part tegmentum, and a dorsal part, tectum. Its main function is pain modulation, vocalization, and cardiovascular control. The pyramidal tracts control movements. The corticopontine tracts help in coordination.[3]
The dorsal tegmentum contains the nuclei of the III and IV cranial nerves. The substantia nigra controls motor activity and the red nucleus in motor coordination. The spinothalamic tract carries pain, touch, and temperature.

**Vascular Supply**[^4]

**Anteromedial:** PCA.

**Anterolateral:** PCA and branches of the anterior choroidal artery. Lateral: posterior cerebellar artery and the choroidal artery. Posterior: SCA, the posteromedial choroidal artery.

**Weber Syndrome**

Symptoms: Ipsilateral III cranial nerve palsy and contralateral hemiplegia. Infarction of the III cranial nerve nucleus and crus cerebri. [Figure 1]

**Benedikt Syndrome**

Symptoms: Ipsilateral III cranial nerve palsy and contralateral weakness, incoordination, and chorea. Infarction of the paramedian midbrain. [Figure 2]

**Claude Syndrome**

Symptoms: Ipsilateral III cranial nerve palsy and contralateral cerebellar hemiataxia and vertical gaze palsy. Infarction of the dorsomedial aspect of the midbrain involving the red nucleus, the superior cerebellar peduncle, and the nucleus of the III cranial nerve. [Figure 3]

**MID Tegmentum Syndrome**

Symptoms: Right VI cranial nerve palsy and left-sided altered thigh sensation and no weakness, or sensory loss. Acute injury to the junction of the medial lemniscus and the nucleus of the VI cranial nerve. [Figure 4]

It represents the lumbar dermatomal representation.

**Pons Anatomy**

The pons has a ventral part and a dorsal tegmentum. The ventral part has longitudinal fibers. Tegmentum contains the nuclei of the V to VIII cranial nerves. Also contains part of the auditory pathway.[^5]

**Vascular Supply**[^4]

**Anteromedial:** Perforators of pontine arteries.

**Anterolateral:** AICA.

**Lateral:** lateral pontine perforating arteries, branches of the basilar artery, AICA or SCA.

**Foville Syndrome**

Symptoms: Ipsilateral VII cranial nerve palsy and contralateral hemiplegia, hemisensory loss, loss of vibration, and proprioception. Infarct of the corticospinal tract, and the VI and VII cranial nerve nuclei. [Figure 5]

**Marie-Foix Syndrome**

Symptoms: Ipsilateral impairment of pain and temperature sensation, ataxia, VII and VIII nerve injury, and contralateral hemiplegia. Infarction of the lateral hemipons, middle cerebellar peduncle, and the VII and VIII cranial nerve nuclei. [Figure 6]

**Locked-in Syndrome**

The patient is de-efferent and to do limb and facial movements, eye-opening is preserved. Infarction of the ventral brainstem involving all voluntary and respiratory muscles. [Figure 7]
Raymond Syndrome
Symptoms: Ipsilateral VI nerve palsy and contralateral hemiplegia.
Infarction of the ventromedial pons involving the VI cranial nerve nucleus and corticospinal tract and sparing of VII cranial.  [Figure 8]

Dejerine Syndrome
Symptoms: Ipsilateral tongue weakness, loss of vibration and proprioception, contralateral hemiplegia. Infarct of the medial medulla affecting the XII cranial nerve nucleus. [Figure 11]

Facial Colliculus Syndrome
Symptoms: Loss of taste sensation in the anterior two-thirds of the tongue, diplopia, and horizontal gaze palsy.
Infarction of the facial colliculus involving the VI and VII cranial nerves.  [Figure 9]

Medulla Oblongata Anatomy
The medulla oblongata has a ventral portion and a dorsal tegmentum. The ventral part contains pyramids and olives. The superior and inferior olivary nucleus has a role in sound perception and cerebellar motor learning respectively. The dorsal tegmentum has the nuclei of IX to XII cranial nerves. [6]

Vascular Supply:[4]
Anteromedial and Anterolateral: anterior spinal artery and vertebral artery. Lateral: PICA.
Posterior: posterior spinal artery.

Wallenberg Syndrome
Symptoms: Diplopia, nystagmus, ipsilateral Horner syndrome and contralateral loss of pain and temperature sensation, dysphagia, and dysarthria.
Infarction of the lateral medulla, inferior cerebellar peduncle, and VIII cranial nerve nucleus.  [Figure 10]

DISCUSSION
Functionally, the brainstem is an important center that is essential in the maintenance of a state of consciousness and physiological activities. Its irreplaceable role in controlling balance, coordinated movement, speech, hearing, eye movement, and swallowing is well known. Brainstem infarction causes ataxia and dysphagia, along with paralysis, diplopia, and dysarthria.[7] Stenosis/occlusion of the vertebrobasilar artery and its branches are the most common etiology of brainstem infarction. Brainstem strokes constitute 10% of all ischemic strokes.[8] Brainstem strokes feature as ipsilateral cranial nerve palsy and contralateral hemisensory loss. Feng-li Zhao et al found that the pons was the most common area of involvement for brainstem infarction which was consistent with the results of some other studies.
Our study also proves the same. Clinical and imaging findings aids in the prediction of prognosis. The classification based on clinical and imaging findings, such as etiology, location, and size helps in predicting prognosis in those patients. MRI increases the rate of detection, as well as detailed information regarding the infarct lesion, such as size, volume, perforating artery involvement, and whether the lesion is located in the supply territory of single or multiple groups of perforating arteries, also can be detected.\[7\] Other possible causes are demyelinating diseases, inflammation, and neoplasms. Clinically they occur as alternating and non-alternating syndromes. Treatment and prognosis depend on etiology. The involvement of descending motor tracts indicates medial lesions; the involvement of long sensory tracts, branchiomotor nuclei, and special sensory nuclei indicates lateral lesions. Posterior circulation stroke has been considered an entity with high morbidity and mortality. Patients presenting with dysarthria, pupillary disorders, lower cranial nerve palsy, hemorrhage, and altered consciousness on admission have a poor prognosis. MRI with DWI has become indispensable in the decision-making process of brainstem stroke management and may provide a means to identify patients who may benefit from intravenous or intra-arterial thrombolysis.

**CONCLUSION**

The brainstem has a complicated anatomy. To interpret brainstem syndromes one should understand the functional anatomy. DWI is highly sensitive for the diagnosis of brainstem infarction. Relevant clinical history and anatomy help in the diagnosis of brainstem infarctions.

**REFERENCES**