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Magnetic Resonance Imaging of Brachial Plexus Pathology.

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Abstract
Brachial plexopathies presents with symptoms that are difficult to diagnose because of complex anatomy and variety of lesions. Precise diagnosis is imperative for prognostic, surgical, and rehabilitative purposes. MRI having excellent multiplanar imaging capability and contrast resolution plays promising role in its evaluation. The present study was conducted with 30 patients clinically suspected of brachial plexopathies, selected and scanned using 1.5 Tesla MRI scanner. Out of 30 patients, 18 (60%) were traumatic and 12 (40%) were non traumatic lesions. Amongst traumatic, post-ganglionic injuries (70%) were common than pre-ganglionic (30%). Stretch injury (66.6%) was most common traumatic lesion, followed by root avulsion and psuedomeningocele in (22%) cases. Secondary tumors in 5 cases (41.6%) were most common cause of non- traumatic lesions, followed by primary tumors in 3 cases (25%). MRI is valuable in identifying, localizing, differentiating and characterizing various lesions which is critical for decision making and surgical planning.

Keywords: Brachial plexus, MRI , peripheral nervous system, Neuropraxic injury

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I. Introduction

Brachial plexus is part of the peripheral nervous system, is a complex anatomical structure carrying motor, sensory and autonomic fibers. It is responsible for innervation of the shoulder, upper extremity, upper chest muscles and cutaneous innervation of the skin of upper limb.

Pathological processes involved can broadly be classified into two categories that are Traumatic and Non-traumatic.

Pathologies are difficult to diagnose because of complex anatomic design of the plexus, varied types of lesions and injuries and Inaccurate clinical examination. EMG only helpful in providing functional implications of the lesions but fails in its localization.

MRI is currently the imaging modality of choice because it helps in differentiating various Traumatic and Non Traumatic lesions,

Classification into pre-ganglionic and post-ganglionic and critical information for management decisions and surgical planning.

The brachial plexus is formed by the ventral roots of C5 to T1 nerve roots which unite to form three trunks. The trunks split into three anterior and three posterior divisions. These unite to form the three cords that further divide into five peripheral nerves.

Imaging anatomy shows that upon exiting their respective neural foramina, the roots travel in the interscalene space, bounded anteriorly by the anterior scalene muscle, posteriorly by the middle/posterior scalene muscles, and inferiorly by the subclavian artery/first rib. At the lateral aspect of the middle scalene muscle, the upper two roots (C5 & C6) join to form the upper trunk, the middle root (C7) continues on as the middle trunk, and the lower two roots (C8 & T1) join to form the lower trunk.

The trunks course supero-posterior to the subclavian artery and each divides into anterior and posterior divisions in the costoclavicular triangle. The costoclavicular triangle has the following boundaries: the clavicle

superiorly, subclavius muscle anteriorly, and the first rib and middle scalene muscles posteriorly. At the lateral border of the first rib, the divisions unite to form the medial, lateral, and posterior cords according to their relation to the ipsilateral subclavian/axillary artery. The cords in turn divide into the terminal nerves: ulnar, median, musculocutaneous, radial, and axillary at the border of the pectoralis minor muscle.

II. Materials And Method:

The study was carried out at tertiary care level hospital. The study was cross sectional analysis comprising 30 patients using standard 1.5 Tesla MRI scanner.

The inclusion criteria included patients with strong clinical suspicion of brachial plexopathies. Patients suspected of thoracic outlet syndrome were excluded from the study.

Scan protocol consisted of Coronal STIR and T1-weighted images with large field of view (FOV) (includes both brachial plexi for comparison) and Sagittal T1-and T2-weighted images with small FOV for high spatial resolution. The T1-weighted images delineate the anatomy of nerves, muscles and vessels as they are outlined by fat. The T2-weighted images reveal the signal abnormalities within the brachial plexus. Short-tau inversion recovery (STIR) images provide uniform and reliable fat suppression over curved surfaces and large field of view.

Intravenous Gadolinium was administered in patients with tumors or mass lesions. Gadolinium was not administered in patients with traumatic brachial plexopathy.

Traumatic brachial plexus injury also includes Sagittal T2-weighted images obtained through the cervical spine, Axial T2-weighted images from C4 to T2 levels and 3D gradient echo (GRE) sequence with thin slices is obtained to look for the nerve root avulsion.

III. Results:

The mean age of patients was 24 years. Young patients were most commonly affected with brachial plexopathies.

Amongst traumatic plexopathies, stretch injury was the most common traumatic lesion involving 12 cases (66.6%) followed by traumatic root avulsion and psuedomeningocele seen in (22%) of cases. Postganglionic (70%) injuries were more common than pre-ganglionic (40 %) injuries. C5, C6 nerve roots (55.5%) were most commonly avulsed, followed by C7 (11.1%) and C8T1 (5.5%).

Non traumatic plexopathies accounted for 40% of the cases, of which secondary tumors in 5 cases (41.6%) were the most common cause followed by primary tumors in 3 cases (25%). It was found that

neurofibroma was the most common primary tumor accounting for 2 cases (16.6%) of the primary tumors followed by schwannoma in 1 case (8.3%). Metastatic breast cancer was the most common secondary tumor in 3 cases (25%) followed by pancoast tumor in 2 cases (16.6%).

IV. Discussion:

Traumatic injuries to brachial plexus

The common causes are road traffic accidents and birth palsy. They are of two types pre-ganglionic lesions are avulsion of the nerve roots at their origin and postganglionic lesions may be lesions in continuity or nerve ruptures The patient may have a combination of both pre- and postganglionic lesions. It is important to differentiate between pre and management. Postganglionic lesions in continuity without disruption of nerve fibers have good prognosis and recover spontaneously with conservative management. Postganglionic lesions with disruption of nerve fibers are treated with surgical repair (nerve grafting).

Preganglionic lesion are teated with nerve transfers to restore function of the denervated muscles.

Neuropraxic injury is seen as T2 hyperintense signal in the roots, trunks, or cords with or without enlargement. Pseudomeningoceles are formed due to extravasation of cerebrospinal fluid through tear of the perineural sheath, seen on T2-weighted images as fluid-intensity lesions at the site of nerve root avulsion. However, presence of a pseudomeningocele is not always seen in nerve root avulsion and vice versa. Nerve ruptures are seen as discontinuity in the neural structures. Associated findings of denervation edema in the muscles may be seen.

Brachial plexus injuries may be associated with injuries to the subclavian artery due to their anatomical proximity to each other. Also post-traumatic pseudoaneurysm of subclavian artery may present with delayed brachial plexus paralysis due to compression of the brachial plexus.

Non-traumatic Brachial Plexus Pathologies

Radiation fibrosis

Patients undergoing radiation therapy in axillary region, may present with brachial plexopathy after several months to years. Radiation fibrosis is seen as diffuse nodular thickening of the brachial plexus and iso- or hypointensity on T1- and T2-weighted images.

Brachial plexus tumors

Nerve sheath tumors (schwannoma and neurofibroma) are seen as ovoid lesions isointense to muscle on T1-weighted images and hyperintense on T2-weighted images with 'target' sign and reveal intense enhancement on administration of gadolinium contrast. Most common benign tumors that involve brachial plexus are lipomas and aggressive fibromatosis. Metastatic breast carcinoma, superior sulcus tumors (non-small-cell lung carcinoma arising from lung apex, and lymphoma involve the brachial plexus frequently.

Brachial plexus neuritis

Acute brachial plexitis presents with severe shoulder and upper arm pain lasting for few days to weeks followed by upper arm weakness. Idiopathic brachial neuritis is of unknown cause but an immunemediated inflammatory reaction following viral infection, vaccination, surgery, pregnancy, etc., has been proposed as etiology.

Image 1:

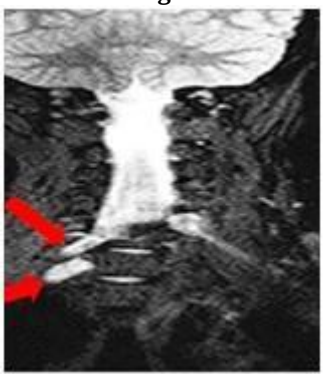

Image 1: Post traumatic pseudomeningocele.

Coronal T2 and STIR images showing CSF intensity outpouching of the right C8 nerve sheath through the neural foramen compatible with a pseudomeningocele.

Image 2:

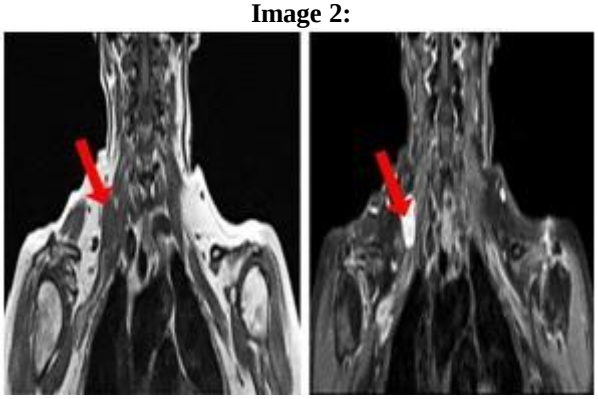

Image 2: Nerve sheath tumor

Coronal T1 and coronal T1 post contrast FS images shows well circumscribed mass arising from the devision of the right brachial plexus,a neurofibroma.

V. Conclusion

MRI is an excellent, non-invasive diagnostic modality having high sensitivity, specificity and accuracy in the diagnosis and characterization of the various pathologies involving the brachial plexus. MRI is the only imaging modality which can reliably distinguish between pre and post-ganglionic lesions, post-radiation plexitis and metastatic tumors; it is also valuable in differentiating and staging the primary and secondary tumors. Thus it provides crucial information for the management and surgical planning of the lesions.

MRI is the single most valuable diagnostic tool in the evaluation of brachial plexopathies obviating the need for multiple imaging or diagnostic procedures. MRI should be done in every patient of suspected brachial plexus pathology, to guide the appropriate management and treatment of the patient.

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