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Magnetic Resonance Imaging Evaluation of Nontraumatic Brachial Plexopathies

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Abstract: *Nontraumatic brachial plexopathies evaluation is a great challenge for the radiologists due to inadequate literature review and less dedicated studies which makes the diagnosisdifficult. Magnetic resonance imaging (MRI) is the modality of choice for evaluating varied spectrum and relevant MRI findings. We have reviewed 101 patientsretrospectively, out of which 26 cases were selected based on clinical and electromyographic evidence of brachial plexopathy. In our institutes, we used 1.5 T GE MRI scanner, 32 channel with dedicated body coil using standard imaging sequences. Results: Neoplastic, infection, radiation induced plexopathies were more common accounting 42 % (11 cases), 23 % (6), 15 % (4) and less common were structural, benign tumors and rarely idiopathic 4 % (1). In both developed and developing countries, neoplastic conditions were most common, infection is second in third world countries while radiation induced plexopathies in the developed, although incidence is decreasing in recent years due to advanced imaging technology.*

Keywords:*anatomy, brachial plexopathies, magnetic resonance imaging, nontraumatic, radiation induced*

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1. Introduction

Brachial plexopathies are conditions affecting the nerve plexuses in the neck region causing sensory or functional impairment of upper limb. The brachial plexus is formed by the nerve roots originating from the C5, C6, C7, C8 and T1 levels. The nerve roots are divided into pre- and postganglionic sections. The brachial plexus is subdivided from proximal to distal: five roots, three trunks, six divisions, three cords and five terminal nerves (5). The causes of nontraumatic brachial plexopathies in adults are several, but common conditions include neoplasms, infection, radiation induced, structural and benign tumors and less common idiopathic etiology (1, 6). The evaluation of brachial plexus seems to be daunting task given the nature of complex anatomy and relatively infrequent dedicated studies. The familiarity of thorough anatomy knowledge and its typical appearance in pathological conditions will allow more confident imaging diagnosis. We make an attempt to study the incidence, etiology and relevant magnetic resonance imaging (MRI) features in the adult onset of non-traumatic brachial plexopathies. With the recognition of various spectrum and their MRI findings, radiologists can effectively communicate with their referring clinicians that will ensure appropriate management.

II. Aims and Objectives

- To assess brachial plexus anatomy, normal and abnormal MR findings of different pathologies
- To assess incidence and various etiologies
- To localize, characterize and diagnosis on MRI to support clinical findings

III. Materials & Methods

We retrospectively reviewed the clinical information of 26 patients those who underwent a total of 101 MR imaging studies from 2014 to 2016 in our institutions. All patients had clinical or electromyographic evidence of a brachial plexopathy. Any patient with a history of trauma or whose imaging studies were unavailable for review or whose imaging findings did not explain their clinical symptoms were excluded. Of the 101 patients, 75 were excluded. All the positive studies were reviewed by two radiologists and all diagnosis were determined by consensus. The final diagnosis were clinically correlated with follow up images. MR imaging was performed with a 1.5-T unit (Signa HCxt; GE Medical Systems). Imaging were performed in the axial, coronal and oblique sagittal planes covering the axilla to middle of the neck. . Axial images parallel to the

disc spaces, coronal images parallel to the vertebrae and shoulders and oblique sagittal images perpendicular to the brachial plexus are obtained. All images were obtained with use of a body coil and section thickness of 4 mm and 1.5 mm intersection gaps. 5 ml of intravenous gadolinium-based contrast was routinely used.

A dedicated protocol is used for imaging of the brachial plexus. Both left and right brachial plexus are imaged to allow comparison and better detection of abnormalities. We use following protocol:

Sequence	FOV (mm)	Matrix	TR (ms)	TE (ms)	ST/GAP (mm)
Coronal STIR	250	256 x 256	2600	62	4 /1.5
Coronal T1	250	256 x 256	550	15	4/1.5
Axial T2	270	256 x 192	2700	62	4/1.5
Axial T1	250	256 x 256	650	12	4/1.5
Sagittal STIR	250	256 x 256	2600	62	4/1.5

STIR: short tau inversion recovery, TE: echo time; TR: repetition time; TSE: turbo spin-echo

IV. Images, Bargraphs, Charts

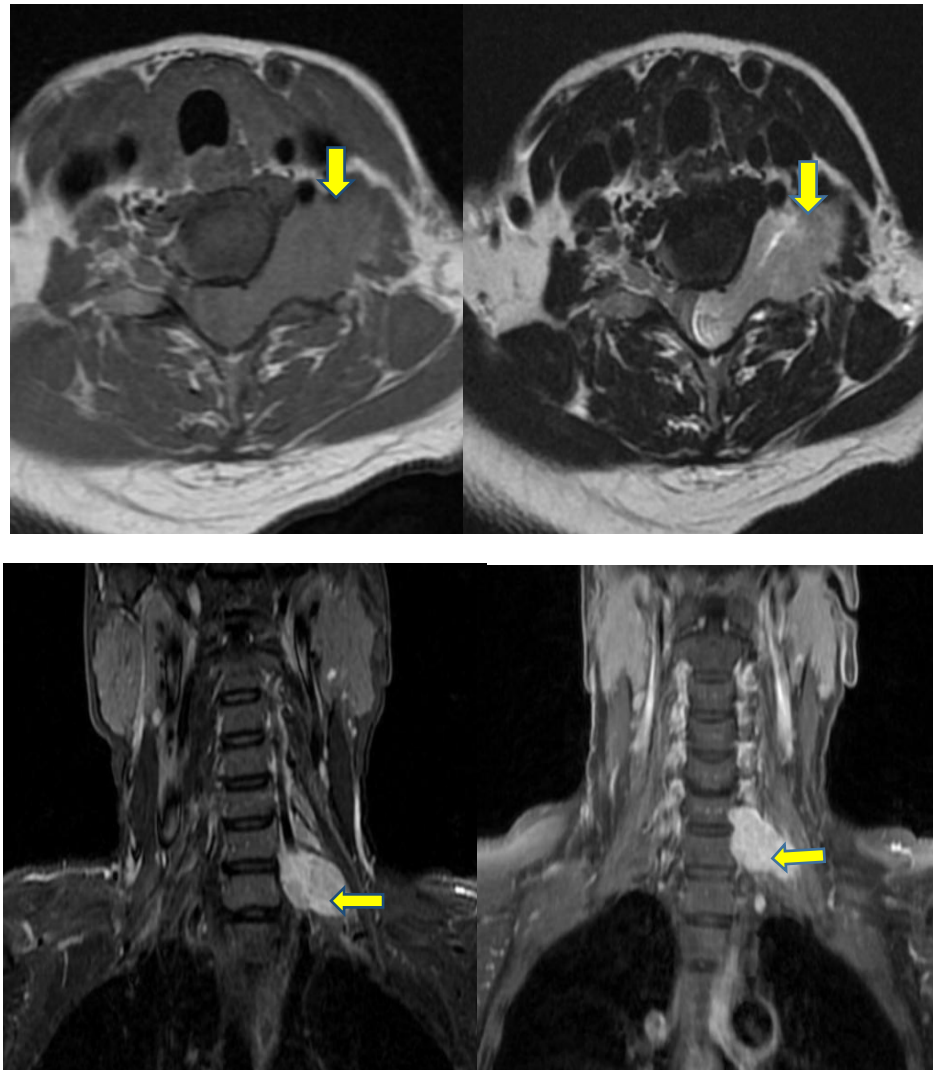


Figure 1 : 42 year old male with peripheral nerve sheath tumor - schwannoma at left C6/7 level presenting as left upper limb weakness. A lobulated soft tissue tumor isointense on T1, hyperintense on T2 with relatively homogeneous post contrast enhancement, causing widening of left exit foramen at left C6/7 (Axial T1, Axial T2, STIR and post contrast T1 mages).

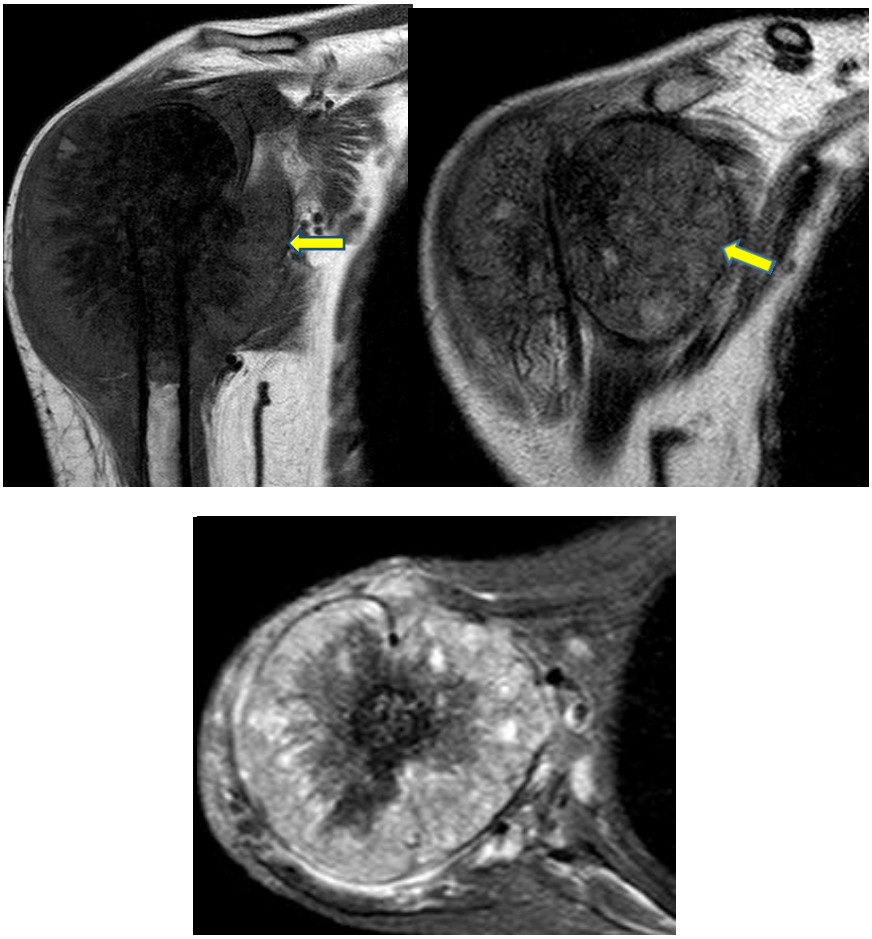


Figure 2: 36 year old female with Osteosarcoma of right proximal humerus. Destructive mass in proximal humerus which is infiltrating the right brachial plexus at the right axilla. A Coronal T1 B. Coronal T2 C. Axial post contrast T1 image (yellow arrow).

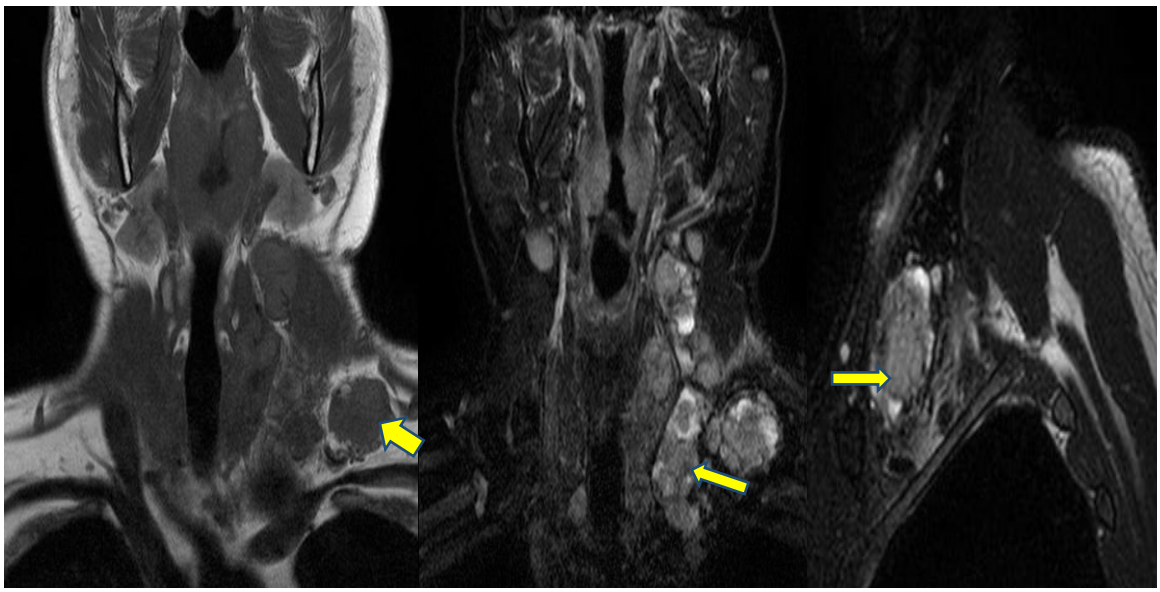


Figure 3: 42 year old female with papillary carcinoma of left thyroid lobe with multiple left cervical nodal metastasis. Multiple left cervical nodal deposits inferiorly compromise the left costoclavicular space causingcompression of left brachial plexus. A Coronal T1 B. STIR coronal C Sagittal STIR image (yellow arrow).

Figure 4: 61 year old male with Pancoast tumor (Squamous cell carcinoma) at right lung apex. Tumor infiltrating the right brachial plexus. A. Coronal T2 B. Post contrast T1 image

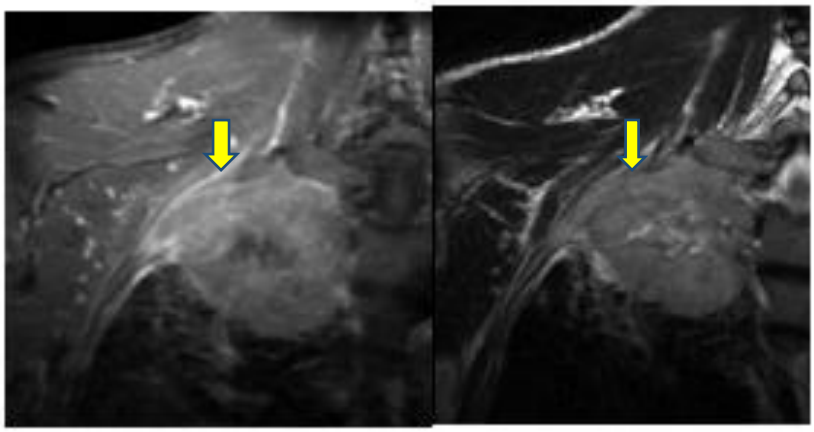


Figure 5: 58 year old female with carcinoma right breast on post RT and chemotherapy presenting with neck pain radiating to right upper limb. A. Coronal STIR, right supraclavicular nodal deposit adherent to mid-lower trunk and divisions of brachial plexus and fat lateral left supraclavicular nodes close to branches of left brachial plexus and subclavian vessels. B. Right oblique STIR image show nodal deposit compromising the right costoclavicular space and compression of right brachial plexus. C. Left oblique STIR image show normal left costoclavicular space.

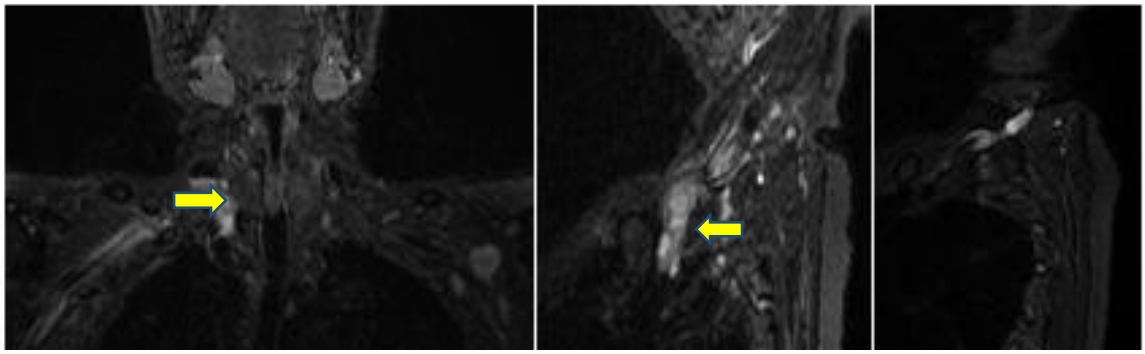


Figure 6: 22 year old female with intramuscular lipoma.A. coronal T2- normal, B coronal T2 , C. Axial T2 D post contrast T1 Fat suppressed images demonstrates lobulated soft tissue mass insinuating into the surrounding structure and compressing the left brachial plexus at the left axilla (yellow arrow).

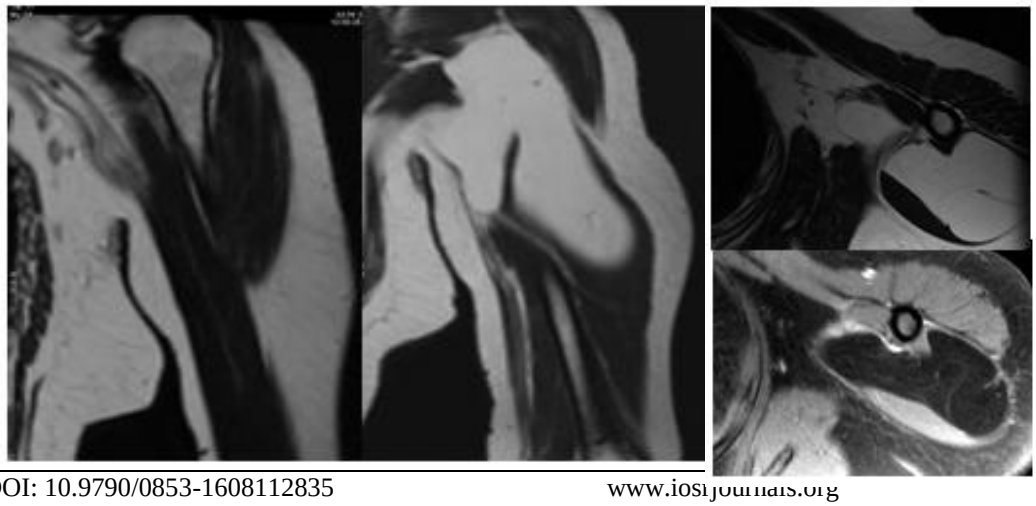


Figure 7: 36 year old male with tubercular spondylodiscitis from C3 to T2 with destruction of C7, epidural, pre and paravertebral abscess. Sagittal STIR, axial T1 and axial T2 TSE showing large abscess extending along exiting nerve roots at C5 to C7 level with impingement.

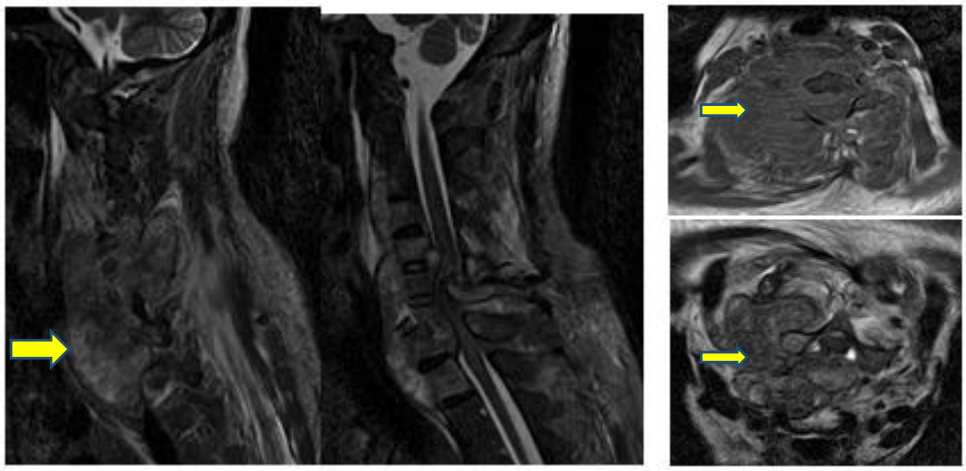


Figure 8: 56 year old male with Carcinoma Tongue and post radiotherapy. Post contrast T1 images demonstrate radiation injury at C3/4 level.

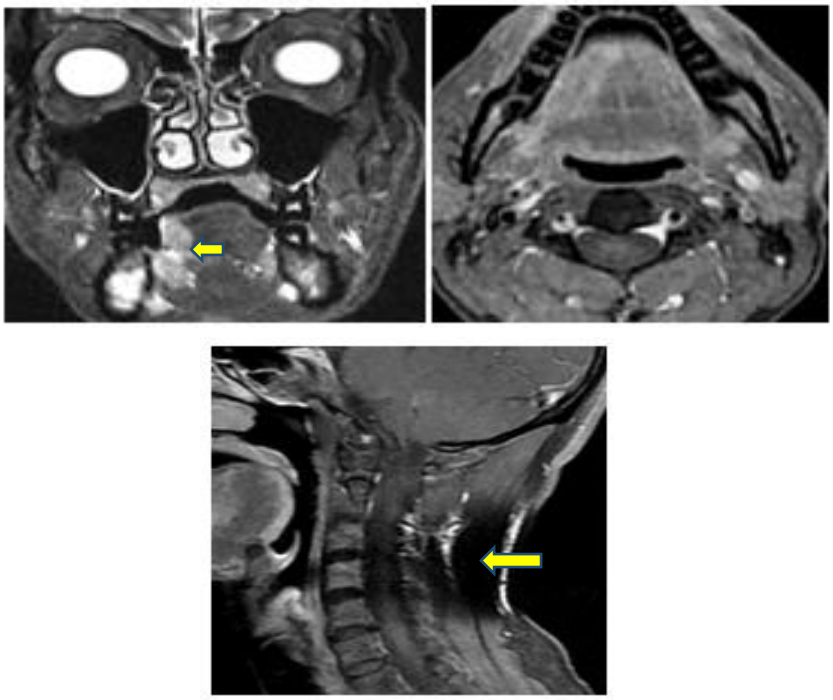
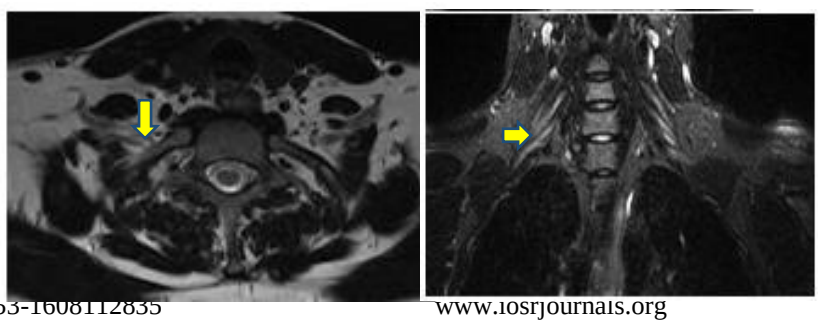


Figure 9: 33 year old male with bilateral cervical ribs presenting with tingling sensation in the left upper limb with numbness (yellow arrow- radiation port)



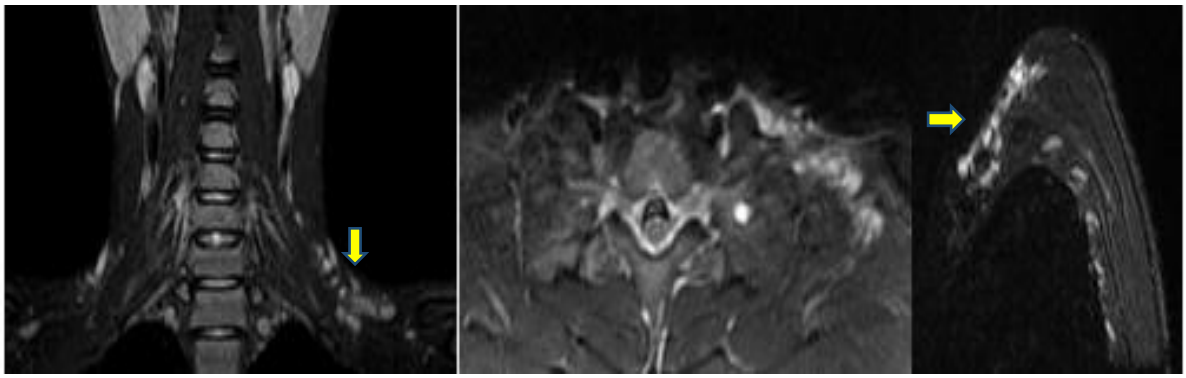
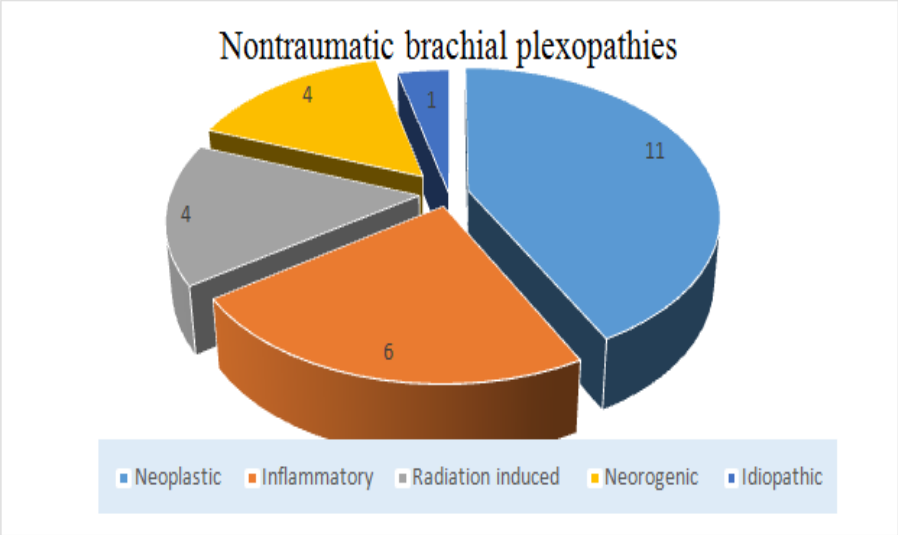


Figure 10: 16 year old boy with small vascular malformation presenting with left upper limb numbness and weakness. A. Coronal STIR show small vascular malformation at the root of neck on left side compressing the lower trunk. B. Axial STIR and C left oblique STIR show mild compression of brachial plexus at left costoclavicular space (yellow arrow).



V. Discussion

Non-traumatic brachial plexopathies can be due to either compression or infiltration by localized pathologies, more diffuse or systemic cause. Slightly more frequent in men as compared to women with increasing prevalence in 30-40 year group. More common causes are neoplastic, inflammatory and radiation fibrosis while less common includes neurogenic thoracic outlet syndrome, idiopathic brachial plexopathy (also known as parsonage-turner syndrome) (1).

Most common etiology of nontraumatic brachial plexopathies was neoplastic and estimated 11 (42 %) of total 26 cases were primary peripheral nerve sheath tumors, of example neurofibromas or schwannomas(figure 1). The neurofibromas and schwannomas are sometime difficult to distinguish on MRI. Both tend to show lesions arising from the nerve with T1-isointense and T2-hyperintense signal changes. The 'target sign' on T2-weighted images, increased signal in the periphery and decreased signal in centrally, more commonly associated with neurofibromas. On other hand, fascicular sign seen on T2 weighted images, rings of peripheral hyperintensity within nerve may favors schwannoma (2). Metastases from other sites are significantly more prevalent than primary tumours, with breast, bone, thyroid, oral and lung carcinomas among the more common primary sites (1). The metastatic infiltration into the surrounding neurovascular structures may lead to various sensory or functional impairment of upper limb. Superior sulcus tumor (three), nodal metastasis of papillary carcinoma of thyroid (two), osteosarcoma of right proximal humerus (one) infiltrating the trunk, cord, terminal branches at various levels to cause neurological symptoms. Few benign intramuscular lipoma due to large size and insinuating nature caused extrinsic compression on the brachial plexus which was

relieved following surgical procedure (figure 6). Other less common entities are lymphoma and plexiform neurofibromatosis. These are lobulated masses, some poorly defined margins with surrounding soft tissue oedema, appear hypointense on T1 weighted and hyperintense on T2-weighted images and post contrast heterogeneous enhancement (figures 2, 3, 4, 5).

Infective is second most cause of brachial plexopathies in the developing country, approximately 23 %of MRI studies. Tuberculosis and bacterial infection leading to spondylodiscitis with subligamentous and paravertebral abscess, extending along the exit foramina causing compression of the exiting nerve roots (7). Some retropharyngeal abscess secondary to dental and oral infections may also cause extrinsic compression of cervical roots. Radiotherapy for lung, breast carcinomas, lymphoma were more frequent than oropharyngeal carcinomacausing chronic inflammation of affected nerves and eventually leading to fibrosis. Though the incidence is less than 1 % today as compared to few decades ago may be due to advanced technology and reduced radiation dose (6). Time interval ranges from few months to years or even decades with most likely with radiation dose of 60 Gy (8). Most common symptoms includes weakness, numbness and paraesthesia of the affected limb, rather than pain (6). On MRI, radiation induced brachial plexopathies include diffuse thickening and enhancement of the brachial plexus without a focal mass(figure 8) and low signal intensity (similar to muscle) on both T1w and T2w weighted images (8,9,10). Although, sometime it is difficult to differentiate radiation induced plexopathies for recurrent tumor inspite of decreased signals on both T1 and T2 weighted due to chronic inflammation and fibrosis (11). Many benign tumors occur along the course of the brachial plexus and involve or impinge on its various components (12). Our cases included neurofibromas, desmoid tumors, vascular malformations and lipoma (figures 6,10). Certain congenital conditions like fibrous band and cervical ribs (13, 14) can cause neurological symptoms from the thoracic outlet syndrome (figure 9). The degree of thoracic outlet obstruction is increased significantly when the arm is hyperabducted, as this causes reduction of the costoclavicular and interscalene spaces. MRI findings include narrowing of the costoclavicular space with hyperabduction of the arm, loss of the fat plane around the brachial plexus (14). Idiopathic brachial plexopathy (neuralgic amyotrophy or Parsonage-Turner syndrome), is a chronic inflammatory demyelinating condition affecting the brachial plexus (15, 16). The etiology is unknown, although some pathologies are suspected, e.g. postviral or following vaccination. We have one case with intramuscular oedema of right supraspinatus muscle with no atrophy. Initial MRI may benormal in 1-2 weeks, after which thickened nerves and cord like structures of brachial plexus (figure 11) was noted. In some cases, there can be T2 hyperintense intramuscular oedema resulting in denervation injury and later followed by atrophy of muscles. The suprascapular nerve, and consequently the supraspinatus and infraspinatus muscles are almost always involved (16).

VI. Conclusion

Evaluation of nontraumatic brachial plexopathies presents a great challenge to the clinician and radiologist. By being familiar with radiological spectrum and relevant MRI findings will supplement clinical findings. Thus accurate diagnosis will boost the therapeutic decision and appropriate better management.

Conflict of interest: Nil
Fund support: Nil

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