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Research Article

ROLE OF MRI IN EVALUATION OF NON TRAUMATIC CAUSES OF BRACHIAL PLEXUS PATHOLOGIES

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ABSTRACT

Prospective-descriptive analysis of MRI Brachial plexus was done in tertiary care hospital involving 70 patients with radiating upper limb pain to evaluate non traumatic causes of brachial plexus pathologies, in view of treatment application and scanty available data. The findings have indicated that in 70 cases studied majority were males. Clinical presentation in majority was unilateral upper limb radiating pain. 9 of them had involvement of brachial plexus. 1 had brachial plexus neuritis, 1 had lymphnode mass compressing cords of brachial plexus, 4 had cervical rib, 2 had neurofibroma involving cords of brachial plexus, 1 had pancoast tumor compressing cords of brachial plexus, 2 had schwannoma involving cords of brachial plexus and 18 cases had exiting nerve root compression due to degenerative changes of cervical spine.

Conclusion: MRI is better modality to assess brachial plexus pathologies

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INTRODUCTION

Brachial plexus is the main sensory and motor innervation of the upper limb. It may be involved in a variety of non traumatic pathologies. MRI is useful both in diagnosis and in localization of these lesions. This makes a significant impact on the management.

Brachial plexus is formed by the ventral rami of C5-C8 and T1 nerve roots. Brachial plexopathies often present with vague symptoms. Clinical examination and electrophysiological studies are useful but may not localize the lesion accurately. MRI has a multiplanar imaging capability and soft tissue contrast resolution and plays an important role in evaluation of abnormal brachial plexus.

Plain radiography can depict large lesions affecting the brachial plexus, however radiographs are far less sensitive than other studies. CT offers poor soft tissue contrast for direct evaluation of the nerves of the brachial plexus.

MRI has become increasingly important in the evaluation of brachial plexus pathology owing to the improved soft tissue resolution. With MRI, not only can the nerve roots, trunks, divisions and cords of the brachial plexus can be better seen but

also the course, caliber, signal intensity, fascicular pattern and size of these components can be better evaluated. Additionally, improved image size, tissue differentiation allows for improved detection of intrinsic and extrinsic pathology. MRI also has the additional benefit for multiplanar imaging. The tissue resolution of MRI is constantly improving with new pulse sequences and coil designs.^{1,2,3,4,5,6,7,8}

MATERIALS AND METHODS

A prospective, cross sectional, observational study was done in a tertiary care hospital from June 2016 to May 2018 involving clinically suspected brachial plexus pathologies. Prior Institutional Ethical Committee clearance was obtained. Informed consent was taken prior to performing the study. Subjects underwent detailed clinical evaluation including history taking.

A 1.5 Tesla MR scanner (Philips Achieva) was used for MR imaging. A combination of body and surface coil depending upon the level of clinically suspected level of the pathology was used. Scan protocol included axial T2, coronal T1, oblique sagittal T1, T2FS, STIR, T1FS contrast (wherever necessary) and

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oblique coronal/coronal STIR with slice thickness of 3mm was employed.

Patients of all age groups with clinically suspected brachial plexus pathology, upper limb peripheral neuropathy, radiating upper limb pain were included. Traumatic cases and any contraindication for MRI like non compatible implants, claustrophobia, 1st trimester of pregnancy etc were excluded.

RESULTS

Total number of cases studied was 70. The study included both genders with age distribution between 0-80 years. The maximum number of patients in our study were from age group of 41-50 years (31.4%). Majority of them were males(62.8%).Clinical presentation of majority of the patients was unilateral upper limb radiating pain(68.5%). 19(27.2%) of them had involvement of brachial plexus. 1(1.4%) case had brachial plexus neuritis, 4(5.7%) of them had cervical rib with no compression to the brachial plexus, 1(1.4%) had a lymphnode mass compressing cords of left brachial plexus, 2(2.8%) cases had neurofibroma involving the cords of right brachial plexus, 1(1.4%) case of pancoast tumor compressing the cords of right brachial plexus, 2(2.8%) cases of schwannoma involving the cords of left brachial plexus and 18(25.7%) cases had unilateral/bilateral exiting nerve root compression due to disc bulge(54%,majority at C5-C6 vertebral level) and disc herniation(24%,majority at C5-C6 vertebral level) and 51(72.8%) of them had no involvement of the brachial plexus however degenerative changes of the cervical spine was noted.

DISCUSSION

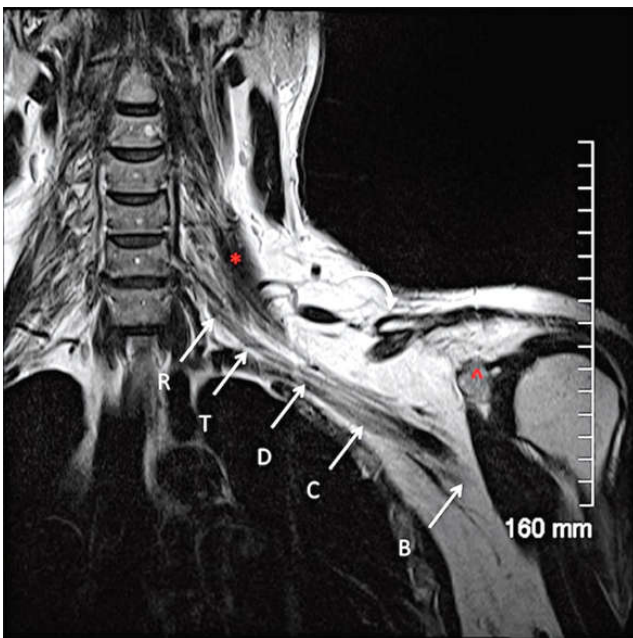


Fig 1 Normal Anatomy A coronal oblique T2W sequence shows the different segments of the brachial plexus. The roots (R) are located medial and within the scalene triangle; the middle scalene muscle (*) demarcates the lateral border of the scalene triangle. The trunks (T) are visualized at the lateral border of the scalene triangle, the divisions (D) between the first rib and the clavicle (curved arrow) and the cords (C) and

the terminal branches (B) on both sides of the coracoid process of the scapula (^).

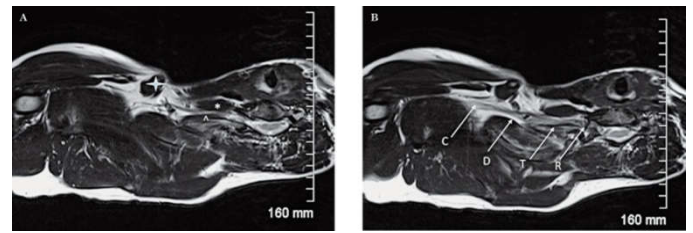


Fig 2 Normal anatomy An axial oblique T2W sequence shows important anatomical landmarks. A) The anterior scalene muscle (*), the middle scalene muscle (^) and the clavicle (arrowhead) are identified. B) It is possible to appreciate how the roots (R) exit the neuroforamina and join within the scalene triangle to form the trunks (T). The divisions (D) are located behind the clavicle and become the cords (C) distally.

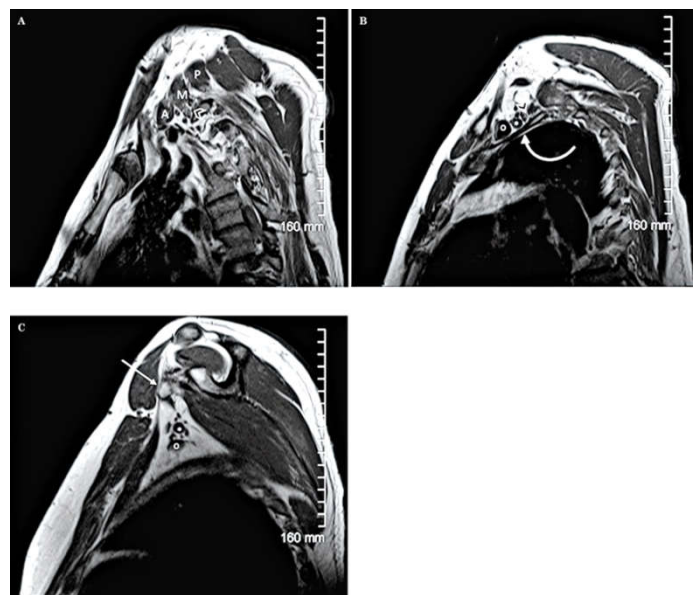


Fig 3 Normal anatomy. Sagittal T1W sequence of the brachial plexus. A) The image shows the 3 scalene muscles (A: anterior, M: middle, P: posterior) and the roots (arrowhead) within the scalene triangle. B) A more lateral image shows the anterosuperior position of the divisions (arrowhead) with respect to the first rib (curved arrow). The subclavian vein (o) is located anterior to the subclavian artery (*) at this level. C) At the level of the axilla and coracoid process (arrow), the proximal branches surround the subclavian artery (*) which is localized above the subclavian vein (o).

Non-Traumatic Brachial Plexus Pathologies

All symptomatic patients who came to Radiology Department in the year 2016-2018 were studied. The number of patients studied was 70 in the age group of 0 to 80 years.

Out of all patients 44 were males and 26 were females. In our study there are more male patients compared to female patients. VM Houghton *et al* studied degenerative cervical discs in 100 patients and found that there was slight male preponderance.⁹

Clinical Presentation

The most common clinical presentation was radiating upper limb pain with unilateral radiculopathy 68.5%, while 31.5% had radiating upper limb pain with bilateral radiculopathy.

A study in Pakistan showed most patients were complaining of unilateral radiculopathy.¹⁰

Disc Bulge - Protrusion and Extrusion

70 patients with upper limb radiating pain were studied at 6 intervertebral disc levels each (C2-C3, C3-C4, C4-C5, C5-C6, C6-C7, C7-T1). Out of 420 intervertebral discs most of them had diffuse disc bulges 226 (54%). Central disc extrusion was seen in 17 (4.2%) and paracentral disc extrusion was seen in 40 (9.7%).

Diffuse disc bulges were mostly seen at C5-C6 level (78%) followed by C6-C7 level (72%), C4-C5 level (60%), C3-C4 level (38%), C2-C3 level (22%) and C7-T1 level (13%).

Paracentral disc extrusion is noted mostly at C5-C6 level (16%) followed by C6-C7 (12%), C4-C5 (12%), C3-C4 (2%), no paracentral disc extrusion was noted in C3-C2 and C7-T1 levels.

Central disc extrusion is noted mostly at C5-C6 level (8%) followed by C6-C7 (4%), C4-C5 (2%). No central disc extrusion was noted in C3-C4, C2-C3 and C7-T1 levels.

Crock HR *et al* maximum disc protrusion were seen at C6-C7 and C5-C6 (90%), C4-C5 (7%), C3-C4 (3%), C3-C2 (3%) and C7-T1 (1%).¹¹



T2W Sagittal & Axial image of the same patient shows disc bulge with narrowing of B/L neural foramina and causing indentation of B/L exiting nerve root at C6-C7 vertebral level.

Brachial Plexus Neuritis

It refers to the inflammatory change involving the brachial plexus due to various causes like viral infection, immune mediated, post radiation, toxic substances etc. 1 case (1.4%) of brachial plexus neuritis on the left side was identified.

Age of the patient was 45 years, complained of left upper limb radiating pain.

Aralasmak A. *et al* conducted a study on brachial plexus neuritis and found that patients between 30 and 70 years of age were maximum (82%) and bilateral involvement was found in 10-30%.¹²

MRI - T2, STIR coronal and coronal oblique sections showed hyperintensity in the cords of brachial plexus on the left side. T1WI coronal oblique shows the cords to be isointense.

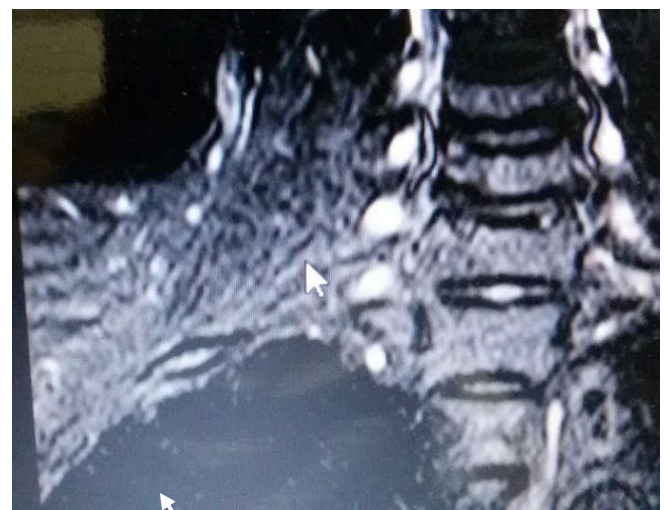
There was no restriction of diffusion on diffusion weighted imaging and no contrast enhancement on T1 post contrast study.



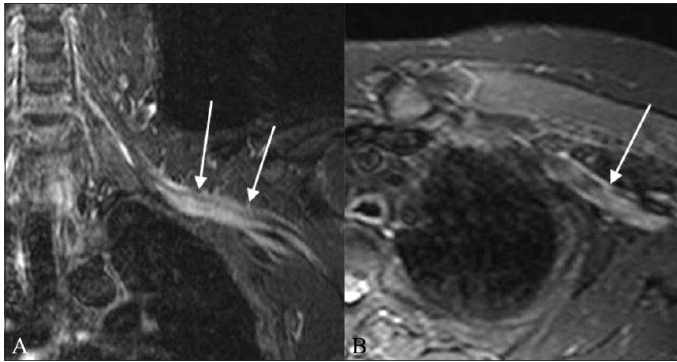
T2W Sagittal and Axial images of 50 years old male patient shows right paracentral and foraminal disc bulge causing right neural foraminal narrowing with compression of right exiting nerve root at C6-C7 vertebral level.



T2W Sagittal & Axial images of 42 year old female patient shows diffuse disc bulge with bilateral paracentral disc protrusion causing cord indentation and narrowing of B/L neural foramina and causing compression of left exiting nerve root at C5-C6 vertebral level.



STIR coronal image of 45 year old male patient shows normal right brachial plexus



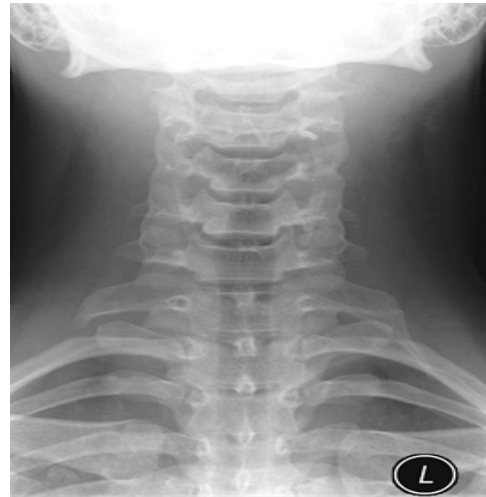
MRI Brachial Plexus Neuritis

Cervical RIB

Cervical rib is a supernumerary or accessory rib arising from the seventh cervical vertebrae. It is one of the cause for thoracic outlet syndrome. 3 out of 4 cases had bilateral radiating upper limb pain with bilateral cervical rib (4.2%) and 1 had right upper limb radiating pain with right sided cervical rib (1-4%).

Nguyen T *et al* did a study on rudimentary first ribs as a case of thoracic outlet syndrome and stated that bilateral involvement is more common.¹³ All the patients were males with equal distribution of age. CT showed the similar findings.

MRI revealed no compression of the cervical rib on to the brachial plexus / subclavian vessels in both neutral and hyper-abduction position.



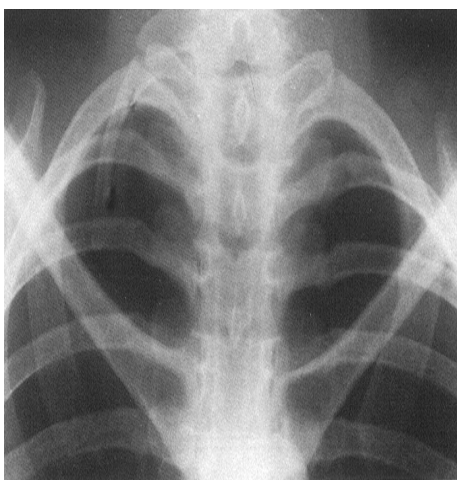
B/L cervical rib



B/L cervical rib



B/L Cervical rib



Right side cervical rib

AP view cervical spine radiograph of 4 different male patients of age 42, 27, 65 and 31 years show B/L cervical ribs, right sided cervical rib, B/L cervical ribs and B/L cervical ribs respectively.



CT image of B/L cervical rib

Axial CT image of the same 27 year old patient demonstrates B/L cervical rib

Lymph Node Mass

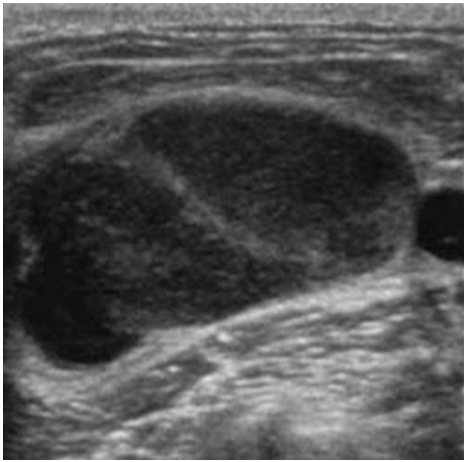
68 years old female patient came with complaints of left upper limb radiating pain.

Ultrasound revealed a well defined predominantly hypoechoic lesion in the left infraclavicular region measuring 2.2x1.6 cms with minimal peripheral vascularity with no hilar pad of fat seen.

NECT demonstrated iso-hypodense lesion measuring the same adjacent to C7 vertebrae in the costoclavicular space on the left side, which showed minimal enhancement on post contrast study.

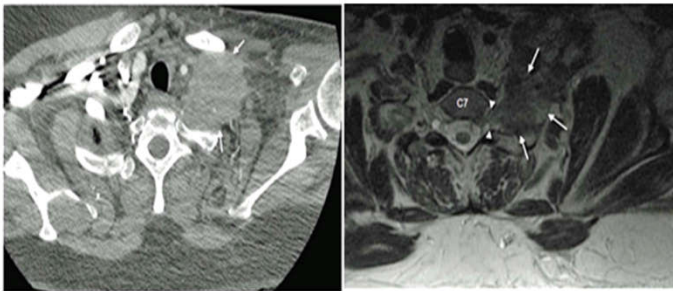
MR revealed T1 hypointense, T2 and PDFS isointense lesion compressing the cords of the brachial plexus on left side. Homogenous enhancement was noted on post contrast study. This was a case of lymph node (surgically excised) enlargement due to adenocarcinoma of lung.

HV Posniak *et al.* described lymph node mass compressing the brachial plexus with similar signal characteristics in their study¹⁴



USG Lymph Node

USG of 68 year old female patient demonstrates a well defined predominantly hypoechoic lesion in the left infraclavicular region - Lymph node



CT and MRI image- Lymph Node

Axial NECT image of the same patient demonstrates iso-hypodense mass lesion adjacent to C7 vertebrae in the costoclavicular space on the left side and the lesion is T1 hypointense on MRI - Lymph node.

Schwannoma

Two patients (2.8%), 58 year old female and 59 year old male came with complaints of left upper limb radiating pain. Cervical spine radiograph revealed no significant abnormality in both the patients.

Ultrasound of 58 year old female patient shows well defined hypoechoic lesion measuring 2.5x1 cm in the subcutaneous plane with minimal internal vascularity, no calcification was seen.

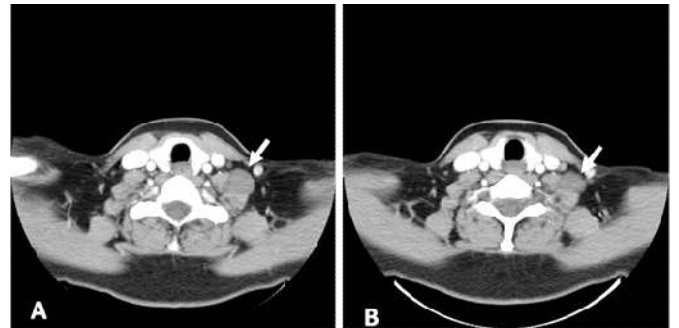
CT shows hypo-isodense lesion measuring 2.5x1.0 cms in the left costo-clavicular space with heterogeneous enhancement noted on post contrast study. MRI shows T2 and STIR hyperintense, T1 isointense lesion with few tiny cystic areas within it with heterogenous enhancement on post contrast study. The lesion is involving the cords of left brachial plexus.

Another case of 59 years old male with left radiating upper limb pain shows a lesion in the left posterior cervical space in the lower neck with two cystic areas within it showing fluid - fluid levels involving the divisions and cords of left brachial plexus with similar signal characteristics and enhancement pattern as of the previous lesion. M Viallon *et al.* described schwannoma arising from the cords of the brachial plexus with similar signal characteristics in their study¹⁵

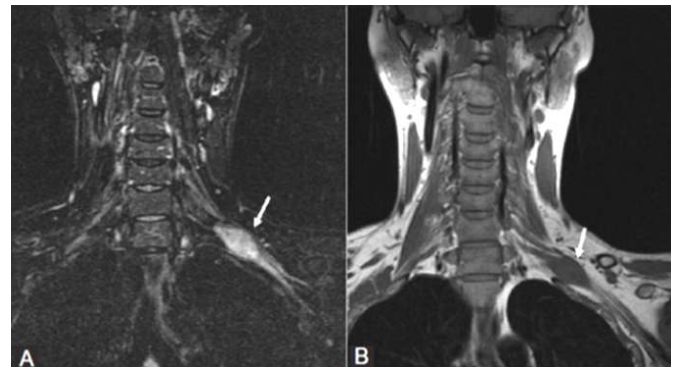
Case-1



USG Schwannoma - USG image of a 58 year old female patient shows well defined hypoechoic lesion in the left infraclavicular region.



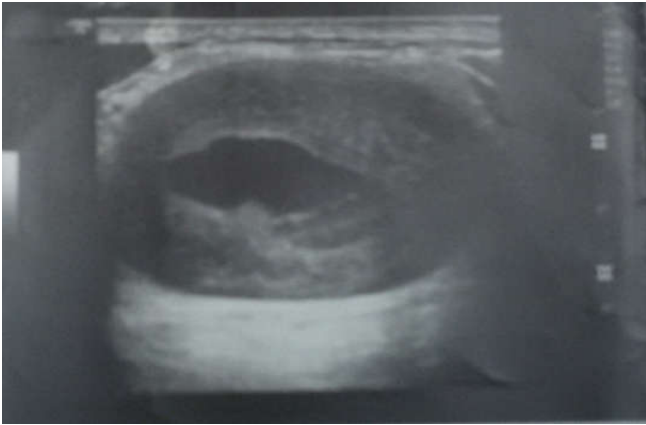
Axial CT image- of the same patient shows hypo-isodense lesion in the left costo-clavicular space.



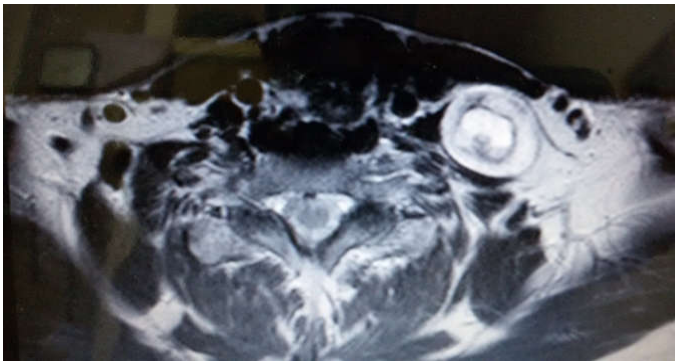
STIR coronal image - of the same patient shows hyperintense lesion involving the cords of left brachial plexus& T1 coronal

image of the same patient shows isointense lesion involving the cords of left brachial plexus - Schwannoma.

Case-2



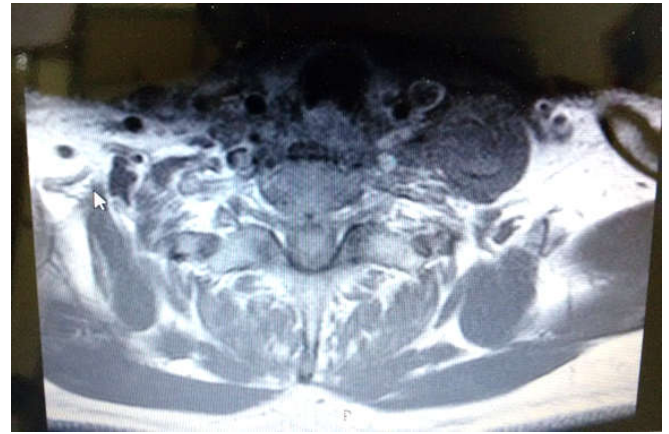
USG image of 59 year old male patient shows well defined hypoechoic lesion with central anechoic cystic area in the lower aspect of the neck on the left side.



T2W Axial image of the same patient shows well defined oval shaped altered signal intensity lesion (peripherally hyperintense) in the left posterior cervical space in the lower neck with two cystic areas within showing fluid - fluid levels - Schwannoma.



STIR Coronal image - of the same patient shows the lesion is hyperintense on STIR coronal in the left posterior cervical space in the lower neck involving the divisions & cords of left brachial plexus - Schwannoma.



T1WI- Axial of the same patient shows the lesion is isointense on T1WI in the left posterior cervical space in the lower neck involving the divisions and cords of the left brachial plexus - Schwannoma.



T1+C Coronal- of the same patient shows the lesion is showing peripheral enhancement on post contrast study.

Pancoast Tumor

65 year old male smoker came with complaints of right radiating upper limb pain since 15 days and breathlessness since 3 days.

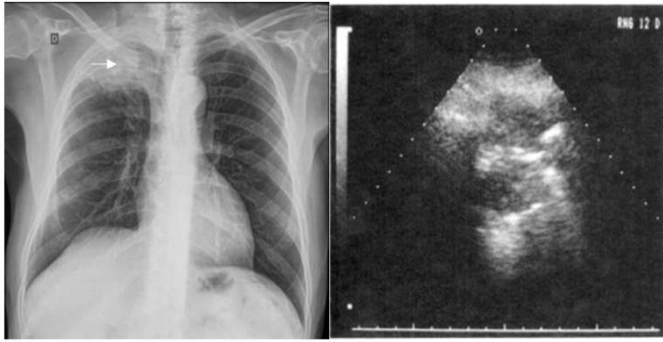
Chest X-ray revealed a homogenous mass lesion in the right upper zone with relatively well defined inferior and medial margins, the lesion is extending above the right clavicle with no clear lung tissue surrounding the lesion. No calcification is seen within the lesion and there are erosions of the 2nd & 3rd ribs on the right side.

USG showed heterogeneous, predominantly hypoechoic mass lesion in right upper lobe.

CT shows iso-hypodense mass lesion in the apical and posterior segments of the right upper lobe and involving the parietal pleura. On post contrast study the lesion showed heterogeneous enhancement with erosions of the 2nd & 3rd ribs. Pre, paratracheal lymphadenopathy was noted.

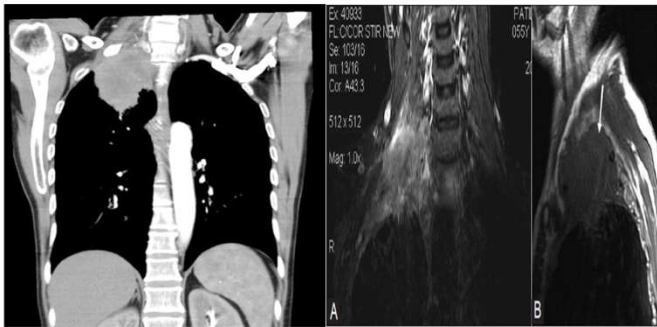
MRI shows T2 and STIR altered signal intensity, T1 isohypotense mass lesion measuring 3.2x2.8 cms in the right upper lobe apical and posterior segments which shows heterogeneous enhancement on post contrast study. The lesion is involving the cords of the brachial plexus on the right side. Mediastinal lymphadenopathy was noted.

Bilsky *et al.* described pancoast tumor with brachial plexus involvement with similar signal characteristics in their study¹⁶



CXR – Pancoasttumor
CXR PA view of a 65 year old male smoker shows a homogenous mass lesion in the right upper zone with erosions of the 2nd & 3rd ribs on the right side – Pancoasttumor.

USG Pancoasttumor
USG image of the same patient shows heterogenous, predominantly hypoechoic mass lesion in the right upper lobe – Pancoasttumor.



CT – Pancoasttumor
Coronal CT image of the same patient shows iso-hypodense mass lesion involving the right upper lobe (aplo-posterior segments) and superiorly extending beyond the right clavicle and causing erosions of the 2nd & 3rd ribs – Pancoasttumor.

STIR coronal STIR sagittal
STIR coronal image of the same patient shows altered signal intensity mass lesion in the right upper lobe involving the cords of brachial plexus on right side – Pancoasttumor.
STIR sagittal image of the same patient shows hypointense mass lesion in the right upper lobe involving the cords of brachial plexus on right side – Pancoasttumor.

Neurofibroma

2 patients (2.8%) 63 and 43 years old male patients presented with complaints of right upper limb radiating pain.

Chest radiograph of the 63 year old male patient revealed homogenous opacity in the right upper zone with indistinct margins. The opacity is situated above the clavicle.

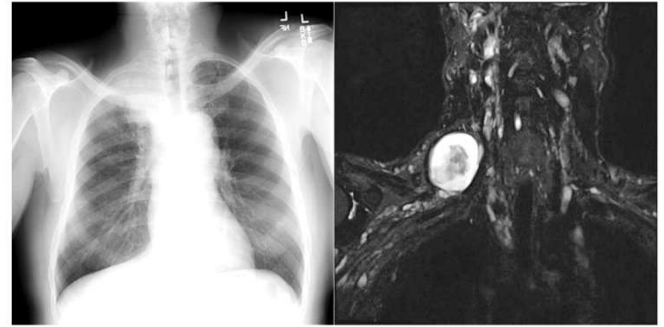
Ultrasound showed a well defined hypoechoic oval lesion with smooth margins along with course of the nerve in the root of the neck measuring 2.2x0.9 cms. There is very minimal vascularity and no calcification is noted within the lesion.

MRI revealed altered signal intensity lesion which is peripherally hyperintense, central hypointense on T2 and STIR, isointense on T1, shows heterogenous enhancement on post contrast study with no areas of blooming on GRE sequence. The lesion is involving the cords of the brachial plexus on the right side with no neural foraminal component.

Another case of a 43 year old male shows a well defined fusiform shaped lesion arising from the right C8 nerve root just distal to the neural foramen with no neural foraminal component with signal characteristics and enhancement pattern as of the previous lesion.

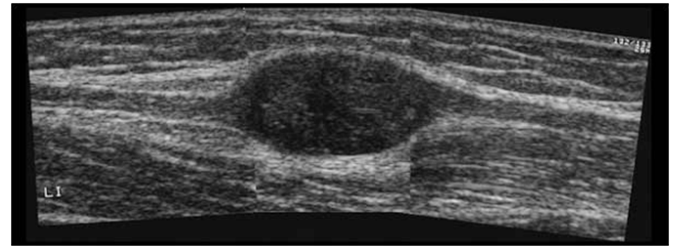
Ferner *et al.* described neurofibroma of the brachial plexus with similar signal characteristics in their study¹⁷

Case-1



CXR Neurofibroma
Chest radiograph PA view of 63 year old male patient shows homogenous opacity noted in the right upper zone.

STIR Coronal Neurofibroma
Coronal STIR image of the same patient shows well defined altered signal intensity lesion involving the cords of brachial plexus on right side with no neural foraminal component - Neurofibroma.



USG - Neurofibroma

Ultrasound image of the same patient shows hypoechoic lesion in the right root of the neck neurofibroma

Case-2



STIR coronal image - of 43 year old male patient shows well defined fusiform shaped hyperintense mass lesion arising from right C8 nerve root just distal to the neural foramen with no neural foraminal component - Neurofibroma.



3D STIR image - of the same patient showing the same lesion as well defined fusiform shaped hypointense lesion arising from right C8 nerve root just distal to the neural foramen with no neural foraminal component - Neurofibroma.



3D STIR MIP image - of the same patient shows the same lesion arising from right C8 nerve root just distal to the neural foramen with no neural foraminal component - Neurofibroma. No cases of radiation plexitis, metastatic infiltration, lymphoma involving the brachial plexus were identified in the study.

Limitations

The study showed no limitations

CONCLUSION

MRI helps to evaluate non traumatic causes of brachial plexus pathologies of the upper limb like compression of the roots, trunks, divisions and cords, in evaluation of pancoast tumor, radiation and inflammatory plexitis, thoracic outlet syndrome, metastatic infiltration, lymphoma, nerve sheath tumor, iatrogenic injury etc.

MRI helps us to study the various appearances, evaluates the extent of the cause and its relationship to the adjacent structures.

Hence MRI is the modality of choice in the evaluation of non traumatic pathologies of brachial plexus.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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