Section: Radio Diagnosis

Original Research Article

SPECTRUM OF MRI FINDINGS IN EVALUATION OF TRAUMATIC AND NON-TRAUMATIC BRACHIAL PLEXOPATHY

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ABSTRACT

Background: Brachial plexus comprises of anterior rami of C5-T1 nerve roots. Roots are located in neural foramina and trunks between scalene muscles. Divisions are posterior to clavicle, and cords are inferior to it.[1] Brachial plexus is the main sensory and motor innervation of the upper extremity. It may be involved in a variety of traumatic and non-traumatic pathologies. In adults, the most common cause of brachial plexus injury is trauma either by compression or traction. Causes of non-traumatic plexopathy includes neoplastic, paraneoplastic, compressive, radiation induced and obstetrical brachial plexus injury.[2] This study aims to present spectrum of MRI findings in traumatic and non- traumatic brachial plexopathy and further extended to involve their distribution considering various epidemiological factors. **Materials and Methods:** In a retrospective observational study conducted in a tertiary care hospital at department of radiodiagnosis, All MRI brachial plexus scans conducted Between January 2024 to January 2025 were analysed. After exclusion of digitally unaccessable, illeligible and unclear records, total of 25 cases were selected. Brachial plexus MRI was performed with 3-T system (Siemens Healthcare) with inclusion of all the standard sequences. All the cases were randomized using Microsoft excel randomisation function and identifiers were removed from each MRI examinations. **Result:** In our retrospective observational study, total distribution of brachial plexopathy cases in percentage were 56 % for traumatic plexopathy, 29 % for non- traumatic plexopathy while 16 % of cases were found normal upon MRI examination. In Traumatic brachial plexopathy, majority of the patients were children and young adults below 30 years of age group with male predominance. While non- traumatic brachial plexopathy was common in relatively older age groups with equivocal gender distribution. **Conclusion:** Brachial plexopathy is difficult in terms of its diagnosis as well as management. With the advent of radiological imaging, especially MRI, it is now possible to quickly diagnose brachial plexopathies easily and facilitate multidisciplinary treatment approach and therefore reducing mortality of these condition.

INTRODUCTION

Anatomy of Brachial Plexus Brachial plexus comprises of anterior rami of C5-T1 nerve roots. Roots are located in neural foramina and trunks between scalene muscles. Divisions are posterior to clavicle, and cords are inferior to it.[1]

Function of Brachial Plexus and Effect of Trauma
Brachial plexus is the main sensory and motor innervation of the upper extremity. It may be involved in a variety of traumatic and non-traumatic pathologies. Brachial plexus injury impacts the sensory and motor function of the innervated limb. In the absence of immediate intervention, brachial

plexus injury leads to functional impairment and disability of the affected limb lifelong. Period of recovery following an injury to the brachial plexus is considered 3 months and therefore early diagnosis, evaluation, and treatment play a critical role in the prognosis of these patients. Localization of lesion is not accurately determined by the help of clinical examination and electrophysiological studies. Here comes the role of MRI, which is helpful in evaluation and accurate determination of brachial plexus lesions. Multi-planer imaging, High soft tissue resolution and non-invasive nature are few advantage provided by MRI which increases its diagnostic yield in evaluation of brachial plexus injury.[2] Classifications of Brachial Plexopathy Brachial plexopathy can be broadly divided into two categories: traumatic plexopathy and non- traumatic plexopathy. In adults, the most common cause of brachial plexus injury is trauma either by compression or traction. Causes of non-traumatic plexopathy includes neoplastic, paraneoplastic, compressive, radiation induced and obstetrical brachial plexus injury.[3]

MATERIALS AND METHODS

Patient Selection: In a retrospective observational study conducted in a tertiary care hospital at department of radio diagnosis, All MRI brachial plexus scans conducted between January 2024 to January 2025 were analyzed. After exclusion of digitally unaccusable, ill eligible and unclear records, total of 25 cases were selected.

MRI Brachial Plexus Protocol: Brachial plexus MRI was performed with 3-T system (Siemens Healthcare). Standard sequences which includes three-plane localizer sequence; an axial T2-weighted sequence using 3D turbo spin- echo imaging with variable flip angle (referred to as "SPACE" on Siemens equipment); axial, coronal, and sagittal T1-weighted sequences; and a fat-suppressed fluid-sensitive sequence in the form of either a T2-weighted sequence with frequency-selective fat saturation or a STIR sequence. Additional three-plane fat-suppressed contrast-enhanced sequences are performed depending on patient history. All the images are acquired using a 5-mm slice thickness. The MRI technician ensured the through-plane coverage and the orientation of the three axis. MRI Protocol for Three-Plane Localizer to Image Brachial Plexus is described in the following table 1.

RESULTS

Another classification is based on injury site: - preganglionic injury, includes injury proximal to the dorsal root ganglion; therefore affecting the central nervous system which does not have the capacity to regenerate. E.g. nerve root avulsion and postganglionic injury, which is distal to the dorsal root ganglion affecting the peripheral nervous system which does have some capacity to regenerate e.g. nerve ruptures and lesions in continuity. However, in clinical practice they can be mixed. According to CT myelography, brachial plexus injuries can be classified into six types.[5]

1. N type: normal root sleeve and nerve roots.
2. A1 type: slightly deformed root sleeves and nerve roots as compared to unaffected site.
3. A2 type: obliteration of the tip of root sleeves and deformed thickened nerve root.
4. A3 type: obliteration of the tip of root sleeves and absent nerve root.
5. D type: root sleeve defect.
6. M type: traumatic meningocele (avulsion pseudomeningocele) formation.

This study aims to present spectrum of MRI findings in traumatic and non- traumatic brachial plexopathy. Study is also further extended to involve their distribution considering various epidemiological factors. In our retrospective observational study, out of 25 cases of brachial plexopathy, 14 cases were of traumatic brachial plexopathy, 7 cases were of non-traumatic brachial plexopathy and 4 cases were found normal upon MRI examination. So total distribution of brachial plexopathy cases in percentage were 56 % for traumatic plexopathy, 29 % for non traumatic plexopathy and 16 % cases were found normal upon MRI examination. Out of all the cases assessed for traumatic plexopathy, motor vehicle accident was the most common cause. In non traumatic brachial plexopathy, acute brachial neuritis and brachial plexus tumors were leading causes. In Traumatic brachial plexopathy, majority of the patients were children and adults below 45 years of age group. Male predominance was found in traumatic brachial plexopathy. While non traumatic brachial plexopathy was common in relatively older age groups. Gender distribution was equivocal in non-traumatic brachial plexopathy. The analysis can be summerized simply in following manner.

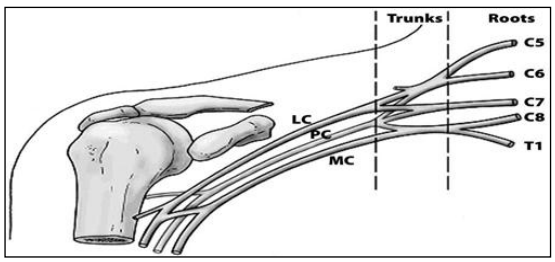

Figure 1 Diagrammatic representation of brachial plexus anatomy. LC = lateral cord, PC = posterior cord, MC = medial cord. [Image Courtesy:- Royal College of Radiologists].

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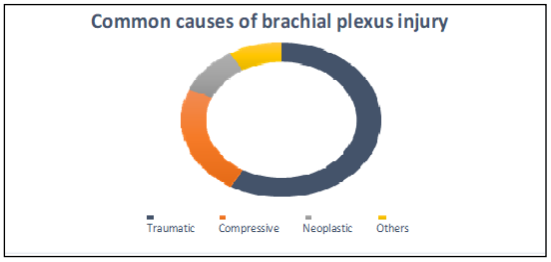

Figure 2 Common causative factors of Brachial Plexus Injuries.[4]

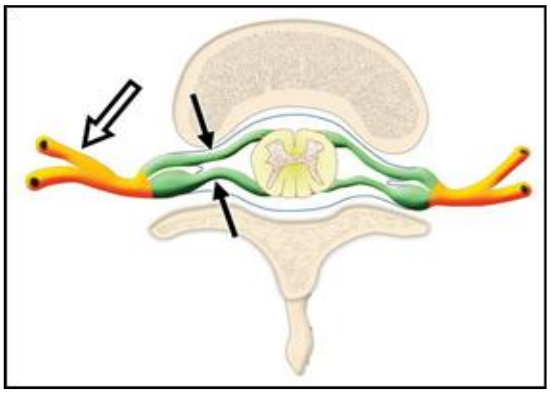

Figure 3 Preganglionic and Post- Ganglionic Nerve Injury. Preganglionic (green) and postganglionic (orange) portions, anterior (motor) and posterior (sensory) rootlets.

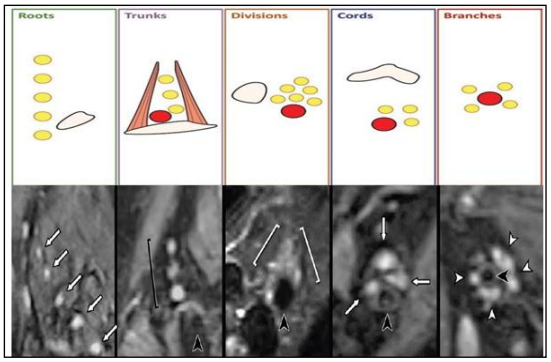

Figure 4 Illustrated and MRI image depicting normal sagittal appearance of roots, trunks, divisions, cords, and terminal branches of the brachial plexus.[1]

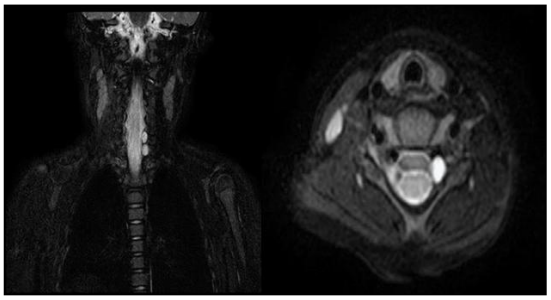

Figure 5: 1 year old with history of fall down with injury to left shoulder 28 days back following which he had complaint of restricted left upper limb movement. T2WI coronal and axial images shows root avulsion injury of left C7 and T1 nerve roots with pseudomeningocele formation at C6-7 and C7-T1 neural foramina. (Pre-ganglionic type of injury).

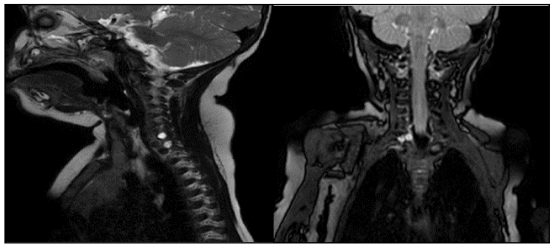

Figure 6: 14 month old baby with history of right shoulder trauma 2 weeks back and presented with reduced right upper limb movements. Coronal and sagittal MRI images depicting root avulsion at C7-T1 with pseudomeningocele, truck and cord injury beyond lateral margins of right scalene muscle. (The Seddon, Sunderland, and MacKinnon – neurotomesis fifth degree injury, mixed Pre and postganglionic type).

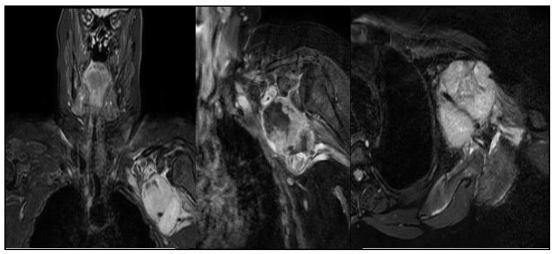

Figure 7: 46 year old female with complaints of reduced power and range of motion of left upper limb with paresthesia since 6 months. Large malignant spindle cell tumor was found upon radiological and histopathological examination along posterior cord of left brachial plexus.

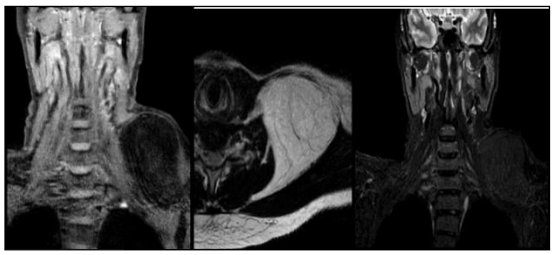

Figure 8: 60 year old male with complaint of tingling sensation in left upper limb since 12 months. On MRI examination there was evidence of well-defined fat signal intensity lesion in left antero-lateral part of neck displacing and compressing the brachial plexus; suggestive of lipoma. (It was further confirmed on histopathological examination)

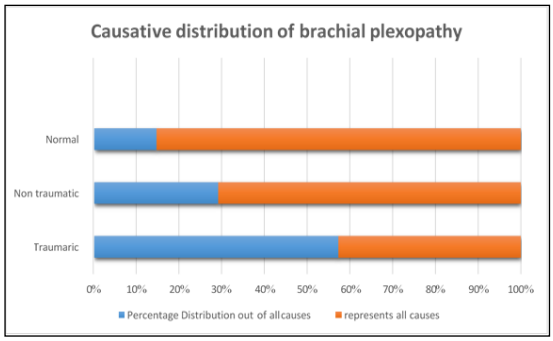

Figure 9 Causative Distribution of Brachial Plexopathies

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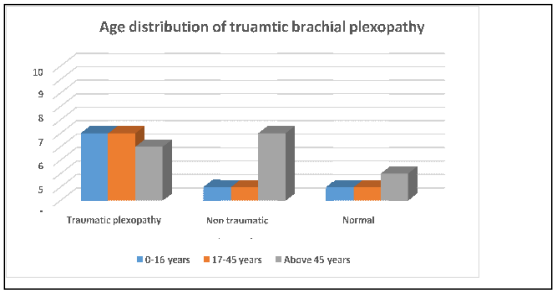

Figure 10: Age wise distribution of traumatic and non-traumatic brachial plexopathy.

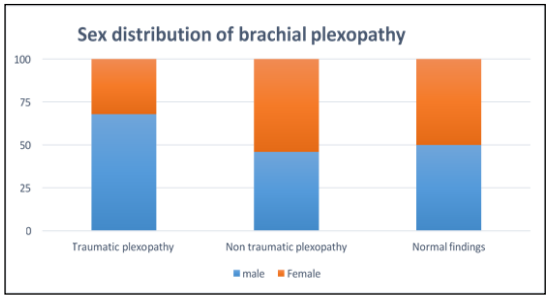

Figure 11 Sex wise distribution of brachial plexopathy.

Table 1: MRI Protocol for Three-Plane Localizer to Image Brachial Plexus (Note: SPACE = 3D turbo spin-echo with variable flip angle on Siemens Healthcare equipment).

Plane	Orientation (°of Axis)	Sequences
Axial	5-10°	T2 – weighted SPACE, T2- weighted with fat saturation or STIR, T1-weighted contrast-enhanced with fat suppression
Coronal	5-7°	T2-weighted with fat saturation or STIR, T1-weighted or proton density-weighted, contrast-enhanced with fat suppression
Sagittal	15°	T2-weighted with fat saturation or STIR, T1- weighted contrast enhanced with fat suppression

Table 2. Imaging Features of Preganglionic and Postganglionic Injuries.

Type of injury based on location	Signs of injury
	T2 hyper intensity at the level of injury
Preganglionic Injury	Discontinuity of nerve rootlets
	Nerve root sleeve expansion
	T2 hyper intensity at site of injury
Postganglionic Injury	Discontinuity distal to neural foramen
	Loss of fascicular architecture or thickening

Table 3: Classification of Traumatic Brachial Plexopathy --- Based on the Seddon, Sunderland, And MacKinnon classification.

Seddon Classification	Sunderland and MacKin Non Classification	Description	Imaging findings
Neuropraxia	First degree	Impaired nerve conduction With intact axons and Connective tissue layers.	Increased T2/STIR signal in nerve only.
Axonotmesis	Second degree Third degree Fourth degree	Axonal disruption, with intact endoneurium, peri neurium, and epineurium. Axonal and endoneurial disruption, with intact perineurium and epineu rium. Axonal, endoneurial, and perineurial disruption, with intact epineurium.	Increased T2/STIR signal in nerve and muscle. Enlargement of nerve fascicle Disruption of nerve fascicle
Neurotmesis	Fifth degree	Complete nerve disruption	Complete disruption of nerve continuity. Muscle shows hyper intensity but with time shows atrophy and undergo fatty replacement.

Image Processing

All the cases were randomized using Microsoft excel randomization function and identifiers were removed from each MRI examinations

DISCUSSION

Normal Imaging Findings in MRI Brachial Plexus

Normal nerves appear isointense to skeletal muscles in T1-weighted images and slightly hyper intense on T2-weighted images. The signal intensity of the nerves of the brachial plexus should be compared with those on the contralateral side to exclude magic angle effect. Normal brachial plexus always appear symmetrical bilaterally. Normal sagittal appearance of the brachial plexus illustrating roots, trunks, divisions, cords, and terminal branches is described as follows. In our study, 16 % of cases having clinical complaint and suspicion of brachial injury were found normal upon MRI examination. MRI Imaging Findings in Traumatic Brachial Plexopathy In adults,

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the most common cause of brachial plexus injury is trauma either by compression or traction. High energy blunt trauma constitutes the major portion compared to penetrating trauma. Iatrogenic injuries also constitutes some of the portion of traumatic brachial plexopathy. Traumatic brachial plexus injuries can be devastating and may result in life-altering functional and cosmetic disability. Traumatic plexopathies are generally classified according to the location, degree and mechanism of injury.

According to location there are two types :- preganglionic injury, which includes injury proximal to the dorsal root ganglion; therefore affecting the central nervous system and postganglionic injury which includes the peripheral nervous system. Imaging findings of preganglionic and postganglionic injury are described in the following table.

Indirect signs of preganglionic injury include pseudomeningocele and denervation of ipsilateral para spinal musculature and post ganglionic injury includes denervation changes confined to musculature of distal end organ. In our study, we encountered 14 cases of traumatic brachial plexopathy out of which 8 were pre-ganglionic and 6 were post ganglionic.

According to severity, traumatic brachial plexopathy are classified as neuropraxia, axonotmesis and neurotmesis. Table 3 represents classification according to severity and imaging findings of the same. In our study out of 14 cases of traumatic brachial plexopathy 3 were under neuropraxia, 6 were under the category of axonotmesis and 5 were under neurotmesis.

Non-traumatic brachial plexopathy can be due to primary or secondary brachial plexus tumours, post irradiation, acute brachial neuritis, thoracic outlet syndrome, compressive or obstetric brachial plexus injury.

In our study out of 7 cases of non- traumatic brachial plexopathy, 2 were under the category of brachial plexus tumors, 3 were under acute brachial neuritis, and 1 was due to compressive force due to adjacent lipoma and 1 was radiation induced injury.

CONCLUSION

Brachial plexopathy is difficult in terms of its diagnosis as well as management. Radiological imaging supplement the findings on physical examination and electrodiagnosis and has proved to be valuable tool. MRI is the best modality among the available radiological tools and therefore plays a key role in diagnosing various brachial plexopathies. Different causative factors and there epidemiological distribution shown in the study will help in identifying predisposed population among the community as well as predisposing condition responsible for various brachial plexopathies. Therefore it will be possible to quickly diagnose brachial plexopathies and facilitate multidisciplinary treatment approach which will further help in reducing mortality of these condition.

REFERENCES

1. 1. Gilcrease-Garcia BM, Deshmukh SD, Parsons MS. Anatomy, imaging, and pathologic conditions of the brachial plexus. Radiographics. 2020;40(6):1686–1714.
2. 2. Shah V, Coroneos CJ, Ng E. The evaluation and management of neonatal brachial plexus palsy. Paediatric Child Health. 2021;26(8):493–497.
3. 3. Lury K, Castillo M. Imaging of the brachial plexus. Apples Radiol 2004; 4:28–32
4. 4. Ferrante, M.A., Brachial plexopathies: classification, causes, and consequences. Muscle Nerve, 2004. 30(5): p. 547-68.
5. 5. Yoshikawa T, Hayashi N, Yamamoto S et-al. Brachial plexus injury: clinical manifestations, conventional imaging findings, and the latest imaging techniques. Radiographics. 2006;26 Suppl 1 (Supplement 1): S133-43.
6. 6. Foster M. Traumatic brachial plexus injuries. eMedicine.com. http://emedicine.medscape.com/article/1268993-overview. Accessed March 2011 Google Scholar
7. 7. Ferrante, M.A., The thoracic outlet syndromes. Muscle Nerve, 2012. 45(6): p. 780-95.
8. 8. Knapik, J.J., et al., Load Carriage-Related Paresthesias: Part 1: Rucksack Palsy and Digitalgia Paresthetica. J Spec Oper Med, 2016. 16(4): p. 74-79.
9. 9. Quantitative MRI Differentiates Electromyography Severity Grades of Denervated Muscle in Neuropathy of the Brachial Plexus. Tan ET, Serrano KC, Bhatti P, Pishgar F, Vanderbeek AM, Milani CJ, Sneag DB. J Magn Reson Imaging. 2022 Oct;56(4):1104-1115.
10. 10. Imaging the anatomy of the brachial plexus: review and self-assessment module. Castillo M. AJR Am J Roentgenol. 2005 Dec;185(6 Suppl):S196-204.

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