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ORIGINAL ARTICLE

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Significance of magnetic resonance imaging in differential diagnosis of nontraumatic brachial plexopathy

Značaj magnetne rezonance za diferencijalnu dijagnozu netraumatskih brahijalnih pleksopatija

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Abstract

Background/Aim. Nontraumatic brachial plexopathies may be caused by primary or secondary tumors, radiation or inflammation. The aim of this study was to present the significance of MRI in revealing the cause of nontraumatic brachial plexopathy. Methods. A two-year retrospective study included 22 patients with nontraumatic brachial plexopathy. In all the patients typical clinical findings were confirmed by upper limb neurophysiological studies. In all of them MRI of brachial plexus was performed by 1.5 T scanner in T1 and T1 FS sequence with and without contrast, as well as in T2 and T2 FS sequences. Results. Seven (32%) patients had brachial plexopathy with signs of inflammatory process, 5 (23%) patients had secondary tumors, in 4 (18%) patients multifocal motor neuropathy was established and in the same number (18%) of the patients postradiation fibrosis was found. Two patients (9%) had primary neurogenic tumors. Conclusion. According to the results of this study MRI is a method which may determine localization and cause of brachial plexopathy. MRI can detect focal nerve lesions when other methods fail to find them. Thus, MRI has a direct impact on further diagnostic and therapeutic procedures.

Key words: brachial plexus neuropathies; diagnosis; magnetic resonance imaging; diagnosis, differential.

Introduction

The brachial plexus is formed from the anterior primary rami from the fifth cervical (C5) to the first thoracic spinal segment (T1), with or without minor branches from the fourth cervical (C4) and the second thoracic (T2) rami. The brachial plexus is a complex structure which carries motor, sensory and autonomic fibers that supply the upper limb.

Brachial plexopathies develop when lesions occur anywhere along the course of the brachial plexus. These lesions are often due to trauma. Nontraumatic brachial plexopathies may be caused by primary or secondary tumors, radiation or inflammation (Parsonage-Turner syndrome, multifocal motor...
neuropathy, post infectious and post vaccination plexitis, chronic inflammatory demyelinating polyneuropathy, connective tissue diseases etc.) 4.

A diagnosis of brachial plexopathy is based on clinical evaluation and electromyography (EMG) 2. EMG may help clarify whether a lesion is central or peripheral, in distinguishing between radiculopathy and plexopathy, as well as in revealing extensiveness and level of lesion 2. However, for precise determination of the localization and characterization of the cause, imaging technique is necessary 7. Magnetic resonance imaging (MRI) is the method of choice in evaluation of brachial plexus pathology because of its multiplanar capabilities and exquisite soft-tissue contrast 5. Normal anatomy of the brachial plexus and surrounding structures is well demonstrated on T1-weighted images, while T2-weighted, fat-suppressed or STIR sequences are important as they provide more specific tissue characterization of the plexus itself 6. Contrast may be useful for more precise characterization of the cause of plexopathy 7.

The aim of this research was to demonstrate the significance of MRI in revealing a cause of nontraumatic brachial plexopathy.

Methods

This retrospective study included patients with brachial plexopathy hospitalized in the Institute of Neurology from January 1st 2008 until December 31st 2009. The clinical diagnosis of brachial plexopathy was based on a specific pattern of muscle weakness, sensory loss and loss of muscle reflexes. The diagnosis was made by the neurologist specialized in peripheral nervous system disorders and it was confirmed by EMG. Patients with a history of trauma of brachial plexus were excluded from the study, thus 22 patients fulfilled inclusion criteria. Four patients exhibited bilateral asymmetrical weakness of muscles innervated by radial, ulnar and/or median nerve. They clinically appeared as multifocal motor neuropathy (MMN). EMG revealed denervation in muscles innervated by aforementioned nerves, but conduction blocks were not observed, thus diagnosis of MMN was not confirmed.

The investigated group consisted of 16 males and 6 females. The mean age of patients was 47.3 ± 11.9 (range 27 to 71) years.

MRI of cervical spine and brachial plexus was performed in all the patients using a Siemens Avanto 1.5 T unit. The following sequences were applied: an axial turbo spin-echo T1 sequence (FoV 280 mm, slice thickness 3.0 mm, TR 561 ms, TE 11 ms, flip angle 150 degree, acquisition number 1, base resolution 320), an axial turbo spin-echo T2 sequence (FoV 280 mm, slice thickness 3.0 mm, TR 3600 ms, TE 127 ms, flip angle 170 degree, acquisition number 1, base resolution 512), a coronal fat-saturated (FS) turbo spin-echo T1 sequence (FoV 350 mm, slice thickness 2.5 mm, TR 550 ms, TE 11 ms, flip angle 150 degree, acquisition number 1, base resolution 256), and a coronal fat-saturated (FS) turbo spin-echo T2 sequence (FoV 350 mm, slice thickness 2.5 mm, TR 7500 ms, TE 157 ms, flip angle 170 degree, acquisition number 1, base resolution 384). The T1 sequences were also made after application of paramagnetic contrast.

Results

MRI imaging in the patients with the admission diagnosis of brachial plexopathy showed signs of inflammation in 7 (32%) of the patients. Secondary tumor was observed in 5 (23%) of the patients and signs of MMN were revealed in 4 (18%) of the patients. The same number of patients was diagnosed with postradiation fibrosis of the brachial plexus (18%), while the remaining two (9%) patients had a primary tumor on MRI imaging (Figure 1).

Fig. 2 – Brachial plexitis (A – coronal T2 FS sequence and B – coronal T1 FS sequence with contrast, show enhanced signal of nerve roots)
started with intensive pain in one shoulder accompanied with muscle weakness and wasting in the same arm after a few days. On the basis of a characteristic clinical presentation, the diagnosis of acute idiopathic brachial neuritis (Parsonage-Turner syndrome) was made. The remaining 4 patients did not feel shoulder pain and the disease progressed more slowly. Additional investigation revealed positive hepatitis C virus (HCV) antibodies in two of four patients.

In all four (18%) patients with clinically suspected MMN, MRI showed focal high signal lesions on T2 sequences and T1 sequences after contrast application along the structures of brachial plexus and ventral rami of cervical roots (Figure 3).

In 5 (23%) of the patients MRI depicted secondary tumors as masses of high signal intensity on T2 sequences and low signal intensity on T1 sequences with signal enhancement after gadolinium contrast application (Figure 4). Additional investigations revealed breast cancer in two female patients, lung carcinoma in two patients and chronic lymphocytic leukaemia in one patient.

Postradiation fibrosis of the brachial plexus was found in 4 (18%) females as a diffuse thickening and enhancement of the plexus structures without visible focal masses, with soft tissue changes of the low signal intensity on both T1 and T2 sequences. Postradiation fibrosis was due to radiation therapy of breast cancer in all the patients.

In two (9%) patients MRI examination revealed a primary neoplasm as a lesion isointense to muscle on T1 and hyperintense on T2 images (Figure 5). Subsequent histopathological findings confirmed the diagnosis of neurofibromatosis in one patient and Schwannoma in the other.
Discussion

Our study shows that MRI can significantly contribute to causal diagnosis of brachial plexopathy. The most common plexopathies in our study were inflammatory (32%) and plexopathies caused by secondary tumors (23%). One previous study from Ireland showed a similar distribution of the most frequent causes of brachial plexopathy. According to Wittenberg et al, with the exception of patients with plexitis, the most common causes of brachial plexopathies are postradiation fibrosis and secondary tumors.

Among the patients with inflammatory plexopathies, 3 were diagnosed with acute idiopathic brachial neuritis (Parsonage-Turner syndrome) on the basis of characteristic clinical presentation. Parsonage-Turner syndrome is the most common form of nontraumatic brachial plexopathy. The cause of brachial plexus neuritis usually remains undetected, but 25% of patients have a preceding infection (usually respiratory) and in 15% of patients plexitis follows different vaccinations. Additional investigation revealed positive HCV antibodies in two patients with signs of diffuse brachial plexus inflammation, but we cannot state with certainty that this infection contributed to the onset of plexitis. MRI is not able to reveal the cause of the inflammatory plexopathy and further investigations are needed, including virological, immunological and cerebrospinal fluid analyses, as well as repeated EMG examinations. However, MRI is of major importance in revealing extentiveness of the inflammatory process which largely determines prognosis of disease. MRI helps in distinguishing between plexitis and radiculopathy because MRI findings may be positive only a few days after the onset of disease while EMG still does not show any abnormalities. Therefore, MRI imaging enables early and accurate diagnosis and unnecessary surgical treatment can be avoided.

In all patients with clinically suspected MMN, MRI showed focal lesions along the structures of brachial plexus and ventral rami of cervical roots. MMN is an immune-mediated demyelinating polyneuropathy characterized by progressive asymmetric weakness and atrophy of the limbs muscles in the distribution of peripheral nerves. Diagnostic criterion for MMN is the presence of conduction blocks on electrodiagnostic studies. However, conduction blocks may be localized in proximal nerve segments and, so, difficult to be detected by EMG as was the case in our patients. These patients may be misdiagnosed with amyotrophic lateral sclerosis (ALS). In these cases, the significance of MRI is crucial. MRI also may distinguish MMN from other inflammatory plexopathies – in MMN patients MRI shows focal high signal lesions on T2 sequences, while in other inflammatory plexopathies MRI usually depicts diffuse and homogenous signal enhancement.

In 23% of the patients MRI revealed a secondary tumor of brachial plexus. In the region of the neck and axilla secondary tumors are more common than primary. Brachial plexopathy caused by metastatic disease or by per continuitatem tumor spread is most often seen in patients with breast and lung carcinoma, lymphoma, leukaemia or multiple myeloma. Secondary deposits are usually iso-intense with primary malignancy. MRI imaging is important in determining further therapeutic approach (surgical, radiation or chemotherapy) as early as possible with regard to the level of plexus infiltration.

Post radiation fibrosis of the brachial plexus was found in 18% of patients due to radiation therapy of breast carcinoma. Radiation plexitis is a subacute or chronic plexopathy with an incidence less than 1%. This damage may occur 6 months to 20 years after completion of radiation (generally after 10–20 months) and it is more likely to occur after doses in excess of 60 Gy. Chronic radiation plexitis is usually presented as postradiation fibrosis and it is most frequently associated with breast cancer radiation therapy, as was the case in our patients. Similar clinical presentation of recurrent tumor, radiation plexopathy and postradiation fibrosis can be frequently overcome with MRI examination. Recurrent tumor appears as a nonuniform, asymmetric, diffuse or focal enlargement with high signal intensity on T2 sequence and with postcontrast enhancement on T1 sequence. Radiation plexopathy is diffuse, uniform, symmetric plexus swelling with high signal intensity on T2 sequence. Postradiation fibrosis appears as symmetric hipointensity on both T1 and T2 sequences.

In 9% of patients MRI examination revealed a primary neoplasm of brachial plexopathy. The most common primary neurogenic tumors of the plexus are neuroma, neurofibroma and Schwannoma, while malignant peripheral nerve sheath tumors are less frequent. Neurofibromas and Schwannomas are iso-intense to muscle on T1 sequence with intense signal enhancement after contrast administration and they are hyperintense on T2 images. Central areas with low signal intensity (the so-called target sign) are more often seen in neurofibroma than in Schwannoma. Histopathological examination is usually necessary to determine the exact type of tumor. Nevertheless, the importance of MRI examination in the diagnosis of primary tumors of the brachial plexus, as well as consequential decision about further diagnostic and therapeutic procedures is unambiguous.

Conclusion

MRI examination, especially T2 sequence with fat saturation and T1 sequence with contrast, enables localization and identification of brachial plexus lesions and narrows the spectrum of possible causes of brachial plexopathies. The exceptional significance of MRI examination is in the detection of focal lesions of the brachial plexus that cannot be detected by other methods. Therefore MRI directly influences the choice of further diagnostic procedures and treatment of patients with brachial plexopathy.
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