COVERAGE:

Magnetic Resonance Spectroscopy (MRS) is considered experimental or investigational.

DESCRIPTION:

MRS is a noninvasive technique that can be used to measure the concentrations of different low molecular weight chemicals. The technique is based on the same physical principles as magnetic resonance imaging (MRI), i.e., the detection of energy exchange between external magnetic fields and specific nuclei within atoms. This energy exchange, measured as a radiofrequency signal in MRI, is then translated into the familiar anatomic image by assigning different grey values according to the strength of the emitted signal. The principal difference between MRI and MRS is that in MRI the emitted radiofrequency is based on the spatial position of nuclei, while MRS detects the chemical composition of the scanned tissue. The information produced by MRS is displayed graphically as a spectrum with peaks consistent with the various chemicals detected. MRS may be performed as an adjunct to MRI. An MRI image is first generated, and then MRS spectra are developed at the site of interest, termed the voxel. While an MRI provides an anatomic image of the brain, MRS provides a functional image related to underlying dynamic physiology. MRS can be performed with existing MRI equipment, modified with additional software and hardware.

MRS has been studied most extensively in a variety of brain pathologies. In the brain, both 1-H (i.e., proton) and 31-P are present in concentrations high enough to detect, and thus have been used extensively to study brain chemistry. For example, proton MRS of the healthy brain reveals four principal spectra:

- Arising from N-acetyl groups, especially n-acetylaspartate (NAA); NAA intensity is thought to be a marker of neuronal integrity and is the most important proton signal in studying CNS pathology. Decreases in the NAA signal are associated with neuronal loss.

- Arising from choline-containing phospholipids (Cho); Choline levels increase in acute demyelinating disease. Brain tumors may also have high signals from Cho.

- Arising from creatinine; In the brain, creatinine is relatively constant and thus is sometimes used as an internal standard.

- Arising from lactate; Normally this spectrum is barely visible, but lactate may increase to
detectable levels when anaerobic metabolism is present. Lactate may accumulate in necrotic areas, in inflammatory infiltrates, and in brain tumors.

Different patterns of the above spectra, in both the healthy and diseased brain, are the basis of clinical applications of MRS. Peripheral applications of MRS include the study of myocardial ischemia, peripheral vascular disease and skeletal muscle.

RATIONALE:

Validation of a new imaging technique involves the following steps:

1. Demonstration of its technical feasibility, including assessment of its reproducibility and precision. For comparison among studies, a common standardized protocol is necessary.

2. An understanding of normal and abnormal values as studied in different clinical situations. For accurate interpretation of study results, sensitivities, specificities, and positive and negative predictive values compared to a gold standard must be known.

3. The clinical utility of an imaging study is related to how the results of that study can be used to benefit patient management. The clinical utility of both positive and negative tests must be assessed. Relevant outcomes of a negative test (i.e., suspected pathology is not present) may be avoidance of more invasive diagnostic tests or avoidance of ineffective therapy. Relevant outcomes of a positive test (i.e., suspected outcome is present) may also include avoidance of a more invasive test plus the institution of specific, effective therapy.

The published data do not indicate that the second two criteria have been met for MRS. While MRS has been investigated in a wide variety of clinical situations, there are no studies specifically focusing on its sensitivity and specificity in specific clinical situations. There are no studies validating how the results of MRS may dictate patient management. For example, MRI is a sensitive tool for identifying space occupying CNS lesions, but it is relatively nonspecific in distinguishing between benign and malignant lesions. MRS can provide a chemical profile of the lesions that may help in this determination. However, no clinical study detailing the positive and negative predictive value of MRS in distinguishing benign and malignant lesions is available. In known malignancies, MRS has been used to assess tumor histology before resection. However, there is no discussion of how this information will influence treatment decisions. For example, the standard approach to CNS tumors is initially complete surgical resection such that exact tumor histology
is not relevant to initial treatment decisions. In this setting, the negative predictive value is probably the most critical statistic; i.e., there is a minimal chance of a missed diagnosis of malignancy. There are no such studies of MRS. After initial treatment, the distinction between tumor recurrence or radiation necrosis is frequently a difficult clinical issue. However, there are no data on whether MRS can be used to make this distinction.

There is much discussion in the literature regarding the role of MRS in diagnosing and monitoring patients with multiple sclerosis (MS). While MRS may provide some powerful insights into the pathogenesis of MS, there are no data how MRS can be used to influence patient management compared to standard clinical assessment and serial MRIs. Similar considerations apply to the use of MRS in other neurodegenerative diseases, such as Parkinson disease, amyotrophic lateral sclerosis, or Alzheimer’s disease. MRS has also been widely investigated as a technique to identify epileptic foci, particularly in the temporal lobes. However, there are inadequate data to validate its performance compared to PET scanning or MRI imaging, or in those patients with equivocal or noncordant PET, MRI, or EEG studies.

MRS has also been investigated in patients with cerebrovascular injury. For example, infarcted areas may be associated with increased levels of lactate and decreased levels of NAA, both detectable by MRS. It has been suggested that changes in MRS may predate changes in MRI, and thus MRS could be used to evaluate stroke progression immediately after acute stroke. Persistence of these abnormalities suggests impaired neurologic functions. Thus MRS may be used to monitor response to thrombolytic therapy, although no specific clinical studies have been reported.

PRICING:

None

REFERENCES:

- Arnold DL, Wolinsky JS, Matthews PM, Falini A. “The use of magnetic
resonance spectroscopy in the evaluation of the natural history of multiple sclerosis”. J Neurol Neurosurg Psych 1998;64(suppl)S94-S101.


A search of the literature was performed on the MEDLINE database for the period of January 1995 through December 1999. The search strategy focused on terms containing the terms “magnetic resonance spectroscopy.”

DISCLAIMER:

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