



## MR IMAGING AND EPILEPSY—3T OR NOT 3T? THAT IS THE QUESTION

### 3T-Phased Array MRI Improves the Presurgical Evaluation in Focal Epilepsies: A Prospective Study

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**BACKGROUND:** Although detection of concordant lesions on MRI significantly improves postsurgical outcomes in focal epilepsy (FE), many conventional MR studies remain negative. The authors evaluated the role of phased array surface coil studies performed at 3 Tesla (3T PA-MRI).

**METHODS:** Forty patients with medically intractable focal epilepsies were prospectively imaged with 3T PA-MRI, including high matrix TSE T2, fluid attenuated inversion recovery, and magnetization prepared rapid gradient echo. All patients were considered candidates for epilepsy surgery. 3T PA-MRIs were reviewed by a neuroradiologist experienced in epilepsy imaging with access to clinical information. Findings were compared to reports of prior standard 1.5T MRI epilepsy studies performed at tertiary care centers.

**RESULTS:** Experienced, unblinded review of 3T PA-MRI studies yielded additional diagnostic information in 48% (19/40) compared to routine clinical reads at 1.5T. In 37.5% (15/40), this additional information motivated a change in clinical management. In the subgroup of patients with prior 1.5T MRIs interpreted as normal, 3T PA-MRI resulted in the detection of a new lesion in 65% (15/23). In the subgroup of 15 patients with known lesions, 3T PA-MRI better defined the lesion in 33% (5/15).

**CONCLUSION:** Phased array surface coil studies performed at 3 Tesla read by an experienced unblinded neuroradiologist can improve the presurgical evaluation of patients with focal epilepsy when compared to routine clinical 1.5T studies read at tertiary care centers.

### MR Imaging of Patients with Localization-Related Seizures: Initial Experience at 3.0T and Relevance to the NICE Guidelines

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The purpose of this study is to describe our initial experience of imaging adults with localization-related epilepsy using MR imaging at 3.0T. We discuss the findings in the context of the recently released NICE guidelines that provide detailed advice on imaging people with epilepsy in the UK. One hundred twenty consecutive people over the age of 16 years with localization-related epilepsy were referred for clinical MR examinations from a regional neuroscience center in England. None of the people had had MR examinations prior to the present study. High-resolution MR imaging was performed taking advantage

of the high field strength and high performance gradients of the system. Two experienced neuroradiologists reported on the examinations independently and the presence and type of pathology was recorded. There was complete agreement between the two reporters in all 120 cases. The overall frequency of abnormalities shown by MR was 31 of 120 (26%) and the commonest abnormality shown was mesial temporal sclerosis found in 10 of 120 (8%). Tumors were shown in 4 of 120, all of which appeared low grade as judged by imaging criteria.

Epilepsy is the commonest neurological condition and demands a significant resource in order to provide good care for sufferers. Recent guidelines published in the UK have suggested that the majority of people with epilepsy should receive brain MR as part of their routine assessment. Our work shows that using the most sophisticated MR imaging in a highly selected population there is a modest pick-

up rate of brain abnormalities. If a widespread epilepsy-imaging programme is started the detection rate is likely to be much lower. Although MR is acknowledged to be a reliable way of detecting pathology in people with epilepsy there is a dearth of information studying the health economics of imaging epilepsy in relation to patient management and outcomes.

## COMMENTARY

In spite of intense efforts under the Clinton administration, legislation for a National Health Plan proved unpopular to lawmakers in Washington and to the general population of the United States. In contrast, a system of socialized medicine has been in place for years in Great Britain. This dichotomy illustrates a fundamental distinction between the political ideologies of each nation. The utilitarian tradition of the British philosophers Bentham and Mill maximizes the greatest good to the greatest number, while the American mindset—best captured by the Scottish philosopher Adam Smith—emphasizes the achievement and rights of the individual. If each individual works to maximize their own personal benefit, society as a whole will ultimately benefit through competition and increased resources. In line with these philosophical–historical traditions, two recent papers on the impact of high-resolution imaging in the treatment of epilepsy have been recently published, one from the United Kingdom and the other from the United States.

From across the Atlantic, in Sheffield, United Kingdom, Griffiths et al. describe the benefit to society of imaging patients with localization-related epilepsy with what they describe as “the most sophisticated MR imaging,” namely, a 3.0T magnet. The article is written in response to recent guidelines published by the NICE (1). Its recommendations state that “neuroimaging should be performed in the majority of epilepsy subtypes and people with epilepsy should have MRI imaging soon after the referral.” The authors find a “modest” rate of discovering brain abnormalities (26%), of which only 18% were related to the epilepsy, mainly mesial temporal sclerosis, tumors, and cortical dysplasia. There is no data provided on patient management, surgical therapy, or outcome. The authors then state that “a high proportion of the pathologies detected do not offer realistic treatment options for improving patient outcomes” and emphasize that there are not enough scanners or neuroradiologists to image the current epilepsy population. Thus, in their opinion, there is little to support a wide-ranging MR imaging program for patients with epilepsy, and the cost-effectiveness of such a program is in doubt.

In contrast, Knake et al., working out of Boston, Massachusetts, present a prospective study of the impact of 3T-PA imaging on patients with localization-related epilepsy. PA imaging, a more sophisticated approach than using 3T imaging alone, involves placing surface coil receivers directly around the head—a procedure that has been estimated to increase the signal-to-noise ratio by a factor of four (2). The authors’ intentions are to identify lesions previously undetected with conventional 1.5T magnets, a goal justified by prior literature that states that detection of an imaging abnormality dramatically increases postsurgical seizure freedom (3,4). All patients previously had been imaged at 1.5T. Among patients with reportedly “normal scans” read by a radiologist familiar with epilepsy at a tertiary care center, a new lesion was detected in 65% of cases, mostly cortical dysplasia. Clinical management was altered in 38%, and surgical outcomes were favorable. The authors’ motivations are clear. In addition to evaluating the efficacy of this novel technology for the greatest good of patients with epilepsy, as the last line of the article suggests, the authors also demonstrate the “diagnostic yield a referring physician can expect if a patient . . . is referred for a 3T PA-MRI.” Hence, the article also serves as an advertisement to increase patient referrals, which will provide a source of revenue to offset the cost of developing and implementing this new technology as well as furnish a potential source of profit for the authors. Adam Smith would be proud.

The juxtaposition of these two articles raises many questions. What the British physicians call the “most sophisticated” available MR technology already appears outdated with the addition of PA coils discussed in the American study. One could argue that the British waste too much time worrying about the cost of implementing an existing technique, which renders them less competitive in the expensive race for technological advancement. In contrast, the American article never addresses the important ethical questions raised by the British article; namely, just because it can be done, it does not mean it should be done. The British article explores the question of the responsibility of the investigator to promote a technology on the basis

of its impact on the whole patient population (i.e., both their disease and their quality of life) as well as its fiscal impact on society at large. The American approach is to justify the technology by providing individual examples of cases in which a patient was helped or a previously unseen lesion was visualized and removed, leading to improved seizure control. However, the cost of the technology is never weighed against the change in quality of life of the population of patients for whom it is intended.

As with many arguments of this sort, the truth undoubtedly lies somewhere in the middle. From a purely scientific standpoint, the ability to turn nonlesional epilepsy into lesional epilepsy by uncovering a previously undiscovered lesion has been demonstrated to improve outcome after resective surgery (3,4) and is an attractive justification for this line of research. However, the American authors may overstate their point by arguing that the ability to see an area of cortical dysplasia, assuming it correlates with the electrophysiology, eliminates the need for invasive monitoring. Their conclusion is not without controversy. Although outcomes are improved after complete, rather than subtotal, resection of cortical dysplasia, it is well known that microscopic cortical dysplasia can be found in adjacent areas of brain, which may be epileptogenic and not visualized on MR (5,6). Hence, removal of the entire epileptogenic region, as defined by invasive electrodes that can extend beyond the borders of the imaged lesion, can be expected to further improve outcome in cortical dysplasia (7). One could even argue that as MR imaging technology improves, clinicians will be able to visualize previously unseen microdysgenesis throughout the brain adjacent to a region of focal cortical dysplasia, which would ultimately stimulate a greater use of intracranial electrodes to ensure these other areas were not epileptogenic. Knake et al. should not be so concerned with eliminating the use of intracranial electrodes as in putting forth their own convincing arguments for 3T PA-MRI. Indeed, the appearance of a subtle lesion can be valuable in localizing electrode placement, ensuring adequate coverage, and determining the full extent of the dysplastic lesion to guide the resection.

Likewise, the British authors likely overstate the lack of utility of improved imaging capabilities. The 3T MRI used in their study, without the addition of PA coils, was able to visualize predominantly mesial temporal sclerosis, low-grade tumors, and cortical dysplasia. It is misleading to state, as they do, that these pathologies offer no reasonable treatment options. The efficacy of surgery for mesial temporal sclerosis has been well established in multiple studies, including prospective randomized studies (8). Likewise, long-term seizure control rates for patients with focal cortical dysplasia of Taylor can be as high as 92%, if resection is guided by intracranial electrodes and clear histological margins (7). In addition, the authors also overstate the economic burdens and demands of the NICE guidelines. The unfortunate reality is that in the United Kingdom and in

the United States only a small fraction of patients with epilepsy are referred for an appropriate presurgical evaluation. Thus, many are deprived of this potentially curative treatment option. Guidelines provide idealized treatment parameters and, as such, should not be made with economic constraints in mind, since they are rarely implemented universally. If these guidelines serve to increase the referrals of patients with epilepsy from primary care physicians to specialized epilepsy centers for appropriate imaging, then they have served their purpose.

Although it is important for health care policy specialists to analyze the economic impact of new technology, it is not productive for the individual researcher or -D-ntist to eliminate potentially advantageous avenues of research because of cost. Science advances in small, steady steps. Although some steps are quite expensive, they may be necessary to reach an ultimate goal. Imagine the day when the initiation, propagation, and etiology of all forms of epilepsy can be imaged noninvasively with unimaginably high resolution, using combined anatomic, physiologic, metabolic, and chemical imaging. Focal or widespread alterations in the synaptic, chemical, and genetic structure of individual neurons and networks might then be altered through the intact skull to attain a cure. Could we ever have walked on the moon if the Wright brothers had worried about the cost of wood for their plane?

by Theodore H. Schwartz, MD, FACS

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