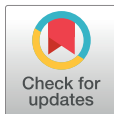




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A Survey of Magnetic Resonance Imaging Protocols for the Investigation of Epilepsy in Canadian Academic Referral Centres

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Nearly 140,000 Canadians live with epilepsy, and many suffer social stigma and economic disadvantage as a result [1]. For patients with medically refractory focal epilepsy, surgical resection of epileptogenic tissue improves seizure control and offers the possibility of seizure freedom [2]. The presurgical workup of these patients involves a triangulation of seizure semiology, electroencephalographic data and neuroimaging data [3]. Magnetic resonance imaging (MRI) plays a critical role in the identification, localization, and characterization of epileptogenic lesions [4]. Patients with chronic focal epilepsy and an epileptogenic lesion identified by MRI have significantly better surgical outcomes, compared with patients who are considered MRI-negative [5,6]. Early use of MRI may also benefit many patients with a first seizure or new-onset epilepsy, as the information gained from MRI can aid in counseling, help with the decision to start antiepileptic drug therapy, and expedite referral for epilepsy surgery when appropriate [7].

MRI has been reported to detect abnormalities in 74% of patients suffering from medically refractory focal epilepsy [8]. The detection rate in this population may be as high as 91% with the use of dedicated epilepsy imaging protocols that are interpreted by experienced neuroradiologists who work at epilepsy referral centres and have access to clinical information about the seizure semiology [9]. One would expect the detection rate to be lower in the relatively undifferentiated group of patients presenting with a first

seizure or with new-onset epilepsy. Indeed, in a recent study of a large cohort of patients presenting to a tertiary care centre with new-onset focal epilepsy, potentially epileptogenic lesions were identified with MRI in 53% of patients [10].

A number of recommendations for epilepsy imaging protocols exist in the literature [4,11–16]. In general, they emphasize the use of multiplanar, multicontrast imaging to distinguish true lesions from partial volume effects, slice angulation perpendicular to the hippocampal axis to optimize the evaluation of temporal lobe pathology, a large matrix with a small field of view, and thin slices with minimal or zero interslice gap to maximize the detection of tiny lesions. Modified protocols are suggested for children and infants [13–16]. However, specific recommendations for MRI sequences vary. As a result, radiologists and clinicians who collaborate in the evaluation and treatment of patients with epilepsy may be unsure if their patients are receiving the best possible imaging care. We surveyed academic referral centres for epilepsy across Canada to provide a snapshot of current expert practice, hoping that teams caring for patients with epilepsy could use our findings as a starting point for discussion and as a benchmark for creating or modifying their own epilepsy imaging protocols.

Materials and Methods

Ethics

This study was approved by the Research Ethics Board of the Nova Scotia Health Authority (Protocol CDHA-RS/2015-310).

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Participants

To obtain a representative sample of academic referral centres across Canada, adult and pediatric health centres affiliated with medical schools were identified in each province that has a medical school. Contact information for a neuroradiologist at each targeted health centre was obtained from the centre's website. Questionnaires were mailed to neuroradiologists at 25 centres. A follow-up electronic version was sent by email.

Questionnaire

In the preface to the questionnaire, respondents were asked to identify their hospital and medical school, answer questions about the services provided to patients with epilepsy, and describe the population served by their hospital (adult, pediatric, or both). The questionnaire proper consisted of 2 parts. The first part focused on MRI protocols for patients with a first seizure, new-onset epilepsy or newly diagnosed epilepsy ("first seizure"), whereas the second part focused on MRI protocols for patients with chronic epilepsy or medically refractory epilepsy ("chronic epilepsy"). Respondents were asked the same questions in each part. They were asked to record the field strength of MRI scanners used for epilepsy imaging and to choose a statement that best describes protocols for epilepsy imaging at their hospital. They were then asked specific questions regarding the use of T1, T2, fluid-attenuated inversion recovery (FLAIR), proton density (PD), gradient recalled echo (GRE), and diffusion weighted imaging (DWI) sequences, and parameters such as imaging planes, slice thickness, and interslice gap. Finally, respondents were asked if specialized MRI techniques are used routinely or sometimes at their institutions, including 3-dimensional (3D) volume acquisitions, gadolinium-enhanced imaging, susceptibility-weighted imaging (SWI), magnetization transfer imaging, diffusion tensor imaging, single-voxel spectroscopy, multivoxel spectroscopy, T2 relaxometry, functional MRI, or any other specialized technique (see [Supplemental Appendix S1](#) for the complete survey).

Analysis

Responses to the questionnaire were tabulated and analysed using descriptive statistics. Categorical data were expressed as absolute values or percentages. Continuous data were summarized by mode, maximum, and minimum values.

Results

Nineteen responses were received between January and August of 2016 (76% response rate). Responses came from Newfoundland, Nova Scotia, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, and British Columbia. Seven of the responding centres serve both adult and pediatric patients, 7 serve adult patients only, and 5 serve pediatric patients

only. Almost all respondents (95%) indicated that their centre is considered a referral centre for patients with epilepsy, and most indicated that their centre offers video telemetry (84%) and epilepsy surgery (79%).

For patients with a first seizure, MRI is used routinely in all centres, and a standardized, dedicated epilepsy protocol is used in 79% of centres. A routine brain protocol is used at 1 adult centre and 1 pediatric centre, respectively. A customized protocol is used at 1 adult centre and 1 combined adult and pediatric centre. Scans are performed at 1.5T in 9 centres, at 3T in 4 centres, and at both field strengths in 6 centres. For patients with chronic epilepsy, MRI is used routinely in all but 1 centre, and a standardized, dedicated epilepsy protocol is used in 95% of centres. A customized protocol is used in 1 adult centre. Scans are performed at 1.5T in 7 centres, at 3T in 5 centres, and at both field strengths in 7 centres.

Figure 1 shows the use of common MRI sequences in the evaluation of patients with first seizure and chronic epilepsy. T2, FLAIR, and DWI sequences are used most commonly for both indications, whereas T1, PD, and GRE sequences are used less commonly. Multiplanar T1, T2, and FLAIR imaging is performed in many centres. Overall, there is little difference in the selection of common MRI sequences and the frequency of multiplanar imaging for the 2 patient groups.

Figure 2 shows the slice orientations for MRI sequences used in the evaluation of patients with first seizure and chronic epilepsy. Coronal T2, FLAIR, and PD images are oriented orthogonal to the hippocampi in the majority of centres using these sequences. However, axial images are oriented parallel to the hippocampi in only a minority of centres, regardless of the MRI sequence used.

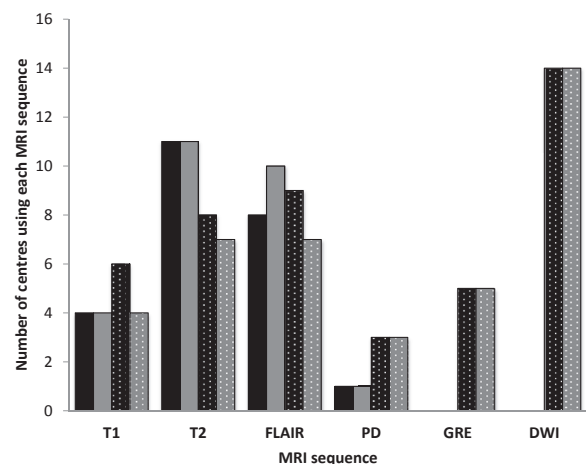


Figure 1. Multiplanar imaging vs single-plane imaging. Common magnetic resonance imaging (MRI) sequences (T1, T2, fluid-attenuated inversion recovery [FLAIR], proton density [PD], gradient recalled echo [GRE], and diffusion-weighted imaging [DWI]) used for the evaluation of patients with a first seizure and with chronic epilepsy at 19 surveyed referral centres across Canada. Black bars represent patients with first seizure and grey bars represent patients with chronic epilepsy. Solid bars represent multiplanar imaging and stippled bars represent single-plane imaging.

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