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An audit of clinical practice, referral patterns, and appropriateness of clinical indications for brain MRI examinations: A single-centre study in Ghana

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ABSTRACT

Introduction: The aim of this study was to investigate current brain MRI practice, pattern of brain MRI requests, and their appropriateness using the American College of Radiology (ACR) Appropriateness Criteria.
Material and methods: We used direct observation and questionnaires to obtain data concerning routine brain MRI practice. We then retrospectively analyzed (i) demographic characteristics, (ii) clinical history, and (iii) appropriateness of brain MRI requests against published criteria.
Results: All patients were administered the screening questionnaire; however, no reviews were undertaken directly with patients, and no signature of the radiographer was recorded. Apart from routine brain protocol, there were dedicated protocols for epilepsy and stroke. Brain MRI images from 161 patients (85 Males; 76 Females) were analyzed. The age group with most brain MRI requests were from 26 to 45 year olds. The commonest four clinical indications for imaging were brain tumour, headache, seizure, and stroke. Using the ACR Appropriateness Criteria, almost 43% of the brain MRI scans analyzed were found to be "usually appropriate", 38% were "maybe appropriate" and 19% were categorized as "usually not appropriate".
Conclusion: There was knowledge gap with regards to MRI safety in local practice, thus there is the utmost need for MRI safety training. Data on the commonest indications for performing brain MRI in this study should be used to inform local neuroradiological practice. Dedicated stroke and epilepsy MRI protocols require additional sequences i.e. MRA and 3D T1 volume acquisition, respectively. The ACR Appropriateness Criteria is recommended for use by the referring practitioners to improve appropriateness of brain MRI requests.

Introduction

Magnetic resonance imaging (MRI) of the brain is the most sensitive technique available for the vast majority of intracranial disease because of its high sensitivity, and higher resolution in exploiting inherent contrast differences of tissues and water content.[1–4] These unique inherent properties, thus allow for the detection of subtle anatomical and vascular changes.[3,4] MRI can provide important pre-surgical information in the investigation of brain tumors.[2] MRI also allows the assessment of invasion of venous sinuses by meningioma, the assessment of optimal sites for biopsy in malignant tumors, and monitoring of the response to treatment.[1] Other indications for MRI include suspected pituitary disease, sensory neural hearing loss, disease of the cerebral white matter, multiple sclerosis, temporal lobe epilepsy and many others.[1,2] The use of contrast media may also be warranted in probing some of these conditions to improve enhancement, characterization and lesion grading.

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In-depth knowledge and understanding on the clinical application of MRI is important in order to produce high quality images. This includes the ability to critically evaluate, justify, and modify protocols (i.e. weightings, pulse sequence parameters) where appropriate in common MRI examinations. As such, the MR protocols employed should be standardized to ensure continuity over time and adapted to the equipment available and requirements of the patient.[5] As a general rule, MRI studies of the brain should include at least two imaging planes and two "weightings," and preferably more.[5] Commonly used weightings in MRI of the brain include T1-weighted (T1W), T2-weighted (T2W), proton-density weighted (PDW), and T2*-weighted (T2*W). T1W images best demonstrate anatomy but after contrast enhancement, it can demonstrate pathology. T2W images are best suited for demonstrating pathology as most lesions have an increased water content and are therefore hyperintense on T2W images. PDW images are also capable of demonstrating anatomy and some pathology. T2*W images best demonstrate haemorrhage. Gadolinium chelates may be administered intravenously when there is suspicion of breakdown of the blood–brain barrier,[1] after which post-contrast T1W images can be obtained in the axial and/or coronal and/or sagittal planes with short TR and TE sequences.

Essentially, to operate the MRI equipment, it is also very important to demonstrate an understanding of the safe use of MRI, particularly in areas such as policy and procedures. In addition, knowledge of the use of contrast agents including safety issues, indications and contraindications are required. Another consideration is that it is expected that a facility with MRI will provide a suitable environment for patients to access their care without any difficulty. This includes putting in place policies regarding the cost of the examination, method of reimbursement, establishment and implementation of picture archiving communication systems (PACS), how images are issued, when the MRI report is ready for collection, and radiologist specialists.

Evidence shows that the availability of imaging and its use has in no doubt contributed to improved health outcomes; however, it is also a strong contributor to increasing healthcare cost, and suspicions of inappropriate or unnecessary use.[6,7] It has been shown that the growth rate of advanced imaging procedures exceeds that of medical cost increases overall.[8,9] The appropriateness of MRI is gaining a wide attention in the medical community, just like other diagnostic imaging modalities. Criticisms around MRI imaging studies being overutilized and inappropriate which generates unnecessary costs and delays.[10] It is estimated that inappropriate imaging are reported to amount to up to 30%, or even up to 77% inappropriate use for certain applications.[11] In British Columbia (Canada), in an analysis of computer tomography (CT) and MRI requests across indications, using a five-point rating scale for appropriateness based on Canadian Association of Radiologists (CAR) guidelines and a meta-analysis of other guidelines, the rates of inappropriate imaging accounted to 2%.[12] Also, in a Finnish University Hospital using the European Commission (EC) referral guidelines, 7% inappropriate examinations were reported.[6] In an analysis of outpatient referrals for CT and MRI using an evidence-based appropriateness criteria from a radiology benefit management company, it was reported that 35%, 37%, and 13% of referrals for MRI of the spine, shoulder, brain and orbits were considered inappropriate respectively.[13] American College of Radiology (ACR) Appropriateness Criteria guidelines[14] have been provided with the intention of enhancing quality and efficacy of health care delivery.[15] The guidelines are evidence based and emphasize appropriate use of testing for accurate staging and tailoring of therapeutic interventions with an aim of reducing unnecessary treatments.[15] Little is known about the level of adherence to these published guidelines within routine clinical practice.[15] However, provision of the level of adherence of these guidelines in routine clinical practice may provide important information for policymakers as they struggle with physicians and patients, who are unhappy with restrictive utilization management programs, and payers and the public, who are looking for ways to decrease health care costs and increase the quality and safety of examinations.

Therefore, the aim of this study was to investigate current brain MRI practice, patterns of brain MRI requests, and their appropriateness. We also retrospectively analyzed (i) demographic characteristics, (ii) clinical history, and (iii) appropriateness of brain MRI requests using the ACR appropriateness criteria.[14]

Materials and methods

This study was in two parts which took place at a public MRI suite in Ghana. We used two methods for collecting data: observation and questionnaire. To generate qualitative data, we used an overt, non-participatory, natural, and systematic observation approach[16] with the goal of gaining a respondent's knowledge of brain MRI practice i.e. patient preparation and screening. The observation was performed over a period of 5 days (30 h in total). With observational methods, there is an epistemological position which suggests that knowledge or evidence of the social world can be generated by observing, or participating in, or experiencing 'natural' or 'real-life' settings, interactive situations and so on.[17] However, it is acknowledged that by trying to obtain consent, the situation of observation may be destroyed.[16] In our case, consent was sought from the respondent. In addition, a structured questionnaire (closed-ended and open-ended) (Table 1) was used with the intention to collect quantitative data.[18]

In the second part, we obtained information from the MRI register which included age, sex, and clinical history of adult patients (aged $\geq$ 18 years) who presented to the suite for brain MRI during the period of 1st January 2017 to 30th May 2017. We then retrospectively analyzed (i) demographic characteristics, (ii) clinical history, and (iii) appropriateness according to the American College of Radiology.[14]

Results

Patient preparation

A patient (safety) screening form was provided to the patients for completion. If all contraindications were ruled out, then the patient was instructed to remove all ferromagnetic items on their body and change into an MRI dedicated gown.

Table 1
Response to MRI practice.

Question	Response
1. What is the MRI scanner field strength?	1.5 T
2. What type of MRI contrast is in use?	Gadovist
3. Do you screen for renal function prior to administering contrast?	No
4. What is the average time of scan?	
- Without contrast?	25 min
- With contrast?	45 min
5. What is the price of brain MRI	
- Without contrast?	GH₵625.00[a]
- With contrast?	GH₵900.00[a]
6. How is the price of MRI reimbursed?	Out-of-pocket; Private health insurance
7. Do you have PACS connected to the MRI system?	Yes
8. When is MRI report issued?	3 days after imaging
9. How are MRI images issued?	Films and Compact Disc

[a] GH₵1 = US$4.2.

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