

Survey of inappropriate use of magnetic resonance imaging

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Abstract

Objective There are concerns that not all costly advanced imaging is appropriate. However, studies about the appropriateness of magnetic resonance imaging (MRI) are sparse. The aim of this study was to review various MRI examinations done at a university hospital to determine whether there is inappropriate use.

Methods Altogether 150 common MRIs (upper abdomen or liver, lumbar spine, knee, head and head of children performed under anaesthesia, 30 each) were reviewed consecutively. The referrals and corresponding patient files were analysed by senior radiologists and the indications of the examinations were compared to the referral criteria.

Results Seven per cent of the examinations were deemed inappropriate. All the MRIs of the head done on children were indicated. One to three examinations in all other subgroups were not indicated. The most common appropriate indications were ambiguous hepatic, pancreatic or adrenal lesions, prolonged lower back pain, suspicion of meniscus rupture, brain malignancy and developmental disorder of a child, respectively.

Conclusions Although the proportion of inappropriate examinations was not high; financial issues and the growing number of patients referred for MRI are of concern. Education and regular use of up-to-date referral guidelines could help to further improve appropriateness.

Main Messages

- *Seven per cent of the MRI examinations analysed were inappropriate at a university hospital.*
- *Everyday practices of a hospital may contribute to the level of appropriateness.*
- *A survey of indications for previous MRI examinations might be helpful in various institutions.*

Keywords Magnetic resonance imaging · Appropriateness · Quality Assurance · Utilisation management · Referral criteria

Introduction

The continuous medical and technological progress has led to an increase in medical imaging, including highly technical non-invasive procedures such as magnetic resonance imaging (MRI), computed tomography (CT) and positron emission tomography-CT (PET-CT). There are clear relationships between the availability of imaging units and their use. This has no doubt resulted in benefits to patients. However, it has contributed to a notable increase in health care costs, and suspicions of inappropriate or unnecessary use of imaging have been highlighted. Excessive imaging may also cause additional need for imaging because of false-positive and extra findings. The use of costly advanced imaging should be based on clear guidelines to ensure appropriate use [1–4]. However, there is a wide range of reasons for referrals, including patients' demands. It is also known that there are institutional and regional differences in imaging practice habits [5, 6].

There was an 87 per cent increase in the number of MRI examinations performed at our university hospital between 2000 and 2008 (6,491 and 12,150, respectively). We had concerns over financial issues, i.e., the increasing costs of imaging and growing number of patients referred for different MRI examinations. We were also planning to increase our MRI capacity as we expected even more demand for MRI scans in the future, partly because MRI avoids the health risk associated with radiation from a CT examination. We also wanted to know whether there was any need to transfer MRI capacity from one anatomical area to another. Studies about the appropriateness of different MRI examinations are sparse [5, 7]. Therefore, we decided to analyse indications for various

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MRI examinations done at a university hospital to determine whether there was inappropriate use.

Materials and methods

Altogether 11,836 MRI examinations were performed at the Department of Diagnostic Radiology of Oulu University Hospital, Oulu, Finland, in 2007. We analysed 150 common MRI examinations: MRI of the upper abdomen or liver (30), lumbar spine referred from the Department of Physical Medicine and Rehabilitation (PMR) (30), knee (30), head (30) and head of children performed under anaesthesia (30). As lower back pain complaints are common and MRI of the lumbar spine is often requested by PMR, we decided to survey that subgroup. We also chose the group of MRI of the head of children done under anaesthesia because there should be good indications for the examination as anaesthesia carries its own risks. Examinations of these groups were extracted from the electronic patient files of our hospital consecutively from the beginning of the year 2007. The evaluation of this study was done in 2009.

Referrals, indications of the examinations, and corresponding patient files were analysed by a senior radiology specialist. Using this information and the referral criteria for imaging recommended by the European Commission (EC) [8], it was decided whether the examination had been indicated. After this, appropriateness of all the MRIs was evaluated by another radiologist trained in neuroradiology (MRIs of the head), abdominal radiology (MRIs of the upper

abdomen or the liver) or musculoskeletal radiology (MRIs of the knee or the lumbar spine) by using the data collected. If necessary, consensus was used.

Results

Seven per cent of all the 150 examinations (10/150) were not appropriate (Table 1). Four out of 30 MRI examinations of the upper abdomen or the liver were not indicated (Table 1). If CT does not reveal any intra-abdominal mass, MRI is not needed. In another patient, suspicion of liver metastases should have been followed by biopsy, not by MRI control. Additionally, CT would be able to show any abnormalities associated with a liver calcification, and the calcification is usually not visible on MRI. A patient with mild upper abdominal pain and without any suspicious symptoms or signs would not have needed MRI. The major indications for appropriate examinations were unclear lesions or status of the liver, pancreas or adrenal gland (20/26 patients) (Table 2).

In the group of MRI examinations of the lumbar spine, 2 out of 30 cases were not appropriate. The problems of the lower legs of one patient were related to a previous assault on the head, not to the lumbar spine. The other patient with mild lower back pain had no specific indications for MRI. Most of the indicated examinations (25/28) had been done for prolonged lower back pain.

Three out of 30 MRIs of the knee were considered non-indicated. MRI does not reveal any special findings in painful knees related to previous Osgood-Schlatter disease. Limited

Table 1 The number of analysed MRIs in different subgroups and the number and indications of inappropriate examinations

MRI	n	Not indicated (n)	Indication (n)
Upper abdomen	15	2	Unclear intra-abdominal expansion at ultrasound, but CT had been normal (1) Control of liver metastases seen at MRI (1)
Liver	15	2	A calcification of liver seen at CT (1) Pain in upper abdomen, ultrasound and laboratory tests normal (1)
Lumbar spine	30	2	Lower leg dysfunction and pain since assault on the head years ago (1) Mild lower back pain, no specific indication (1)
Knee	30	3	Previous Osgood-Schlatter disease, now pain in the knees (2) Limited flexion and extension without any trauma (1)
Head	30	1	A terminal patient with defatigation and rapid deterioration, several CTs lately (1)
Head, children (anaesthesia)	30	0	
All	150	10	

flexion and extension of the knee were the only information concerning the other patient while referring and performing MRI and would not have indicated MRI. The indication for an appropriate examination was suspicion of meniscus rupture in 19/27 cases.

One out of 30 MRI examinations of the head was not appropriate. There was no indication for MRI after many CT examinations in the case of an elderly terminal patient. The most common appropriate indications were control of a brain tumour or suspicion of brain metastases (9/29). All the MRI

Table 2 The number and indications of appropriate MRI examinations in different subgroups

MRI	n	Indicated (n)	Indication (n) *
Upper abdomen	15	13	Unclear hepatic/hepatic hilar/pancreatic or adrenal lesion/status (10) Unclear pancreatic duct dilatation (1) Follow-up after laser ablation of a tumour of the kidney (1) Previous cancer (kidney+GIST**), pain and elevation of tumour marker (1) Exclusion of residivous pancreatic-cutaneous fistula before operation of lumbar hernia (1) Leukaemia, control of hepatic fungal infection before stem cell transplant (1)
Liver	15	13	Unclear/follow-up of liver lesions (10) Suspicion of sclerosing cholangitis (1) Leukaemia, symptoms of infection (1) Pain, fever and biliary stasis at ultrasound after laser ablation of hepatocellular carcinoma (1)
Lumbar spine	30	28	Prolonged lower back pain (25) Prolonged lower leg symptoms (2) Postoperative lower back pain (1)
Knee	30	27	Suspicion of meniscus rupture (19) Suspicion of cartilage lesion (3) Oedema and opaque synovial fluid (1) Control of liposarcoma (1), myxoma (1) Suspicion of a loose body (1), detached biceps muscle (1) Abnormal bone structure in plain x-ray (1) Previous meniscus operation, postoperative pain (1)
Head	30	29	Control of brain tumour/suspicion of brain metastases (9) Unclear unconsciousness (+ convulsion) (4) Headache (+ visual symptoms) (3) Suspicion of demyelination (2), a cavernoma (1), memory disorder (1), early Parkinson disease (1), sinus thrombosis (1) Epidemic nephropathy, a study (1), control of brain trauma, a study (1) Previous paraplegia, brain contusion, now weakness of upper arms (1) Screening of aneurysm (1) Control of traumatic bleeding (1) Control of a previous finding (1) [One MRI done in error (1)]
Head, children (anaesthesia)	30	30	Developmental disorder (9) Control of a previous finding (4) Headache/nocturnal nausea (4) Seizure of absence (4) Excessive growth of the head (2) Leukaemia, planned stem cell transplant (2) Visual symptoms/stasis papillae (2) Previous head trauma, acute symptoms of the limbs (1) Leukaemia, acute brain-based symptoms (1) Premature infant with intracerebral haematomas, later stiffness of the limbs (1) Osteopetrosis, status of cranial nerves (1) Control of brain tumour (1) Fracture of the skull vault, liquor leakage from the ear (1)
All	150	140	

*Some patients had more than one symptom/indication

**GIST, gastrointestinal stromal tumour

examinations of the head performed in children under anaesthesia were indicated. The major indication for MRI was a developmental disorder (9/30).

Discussion

Appropriate use of both MRI and CT is very important both medically and economically. There are suspicions of various forces influencing overutilisation in many countries, such as financial incentives, self-referrals and defensive medicine [1, 5]. These are probably not major problems in Finland, but we do have concerns about duplicate imaging studies and patient expectations. Institutional and regional variations in imaging patterns and practices may affect appropriateness as well [5, 6].

Seven per cent of the MRI examinations analysed in our study were inappropriate. In another study of 3,367 hospitals, the use of outpatient imaging varied widely, possibly indicating overuse. Low imaging volume, a rural setting, for-profit ownership and non-teaching hospitals were more likely to report the highest use. Lack of details about patients' clinical data was reported to be one of the limitations of the study [6]. Another report concerning outpatient CT and MRI scans revealed a 70-fold difference between hospitals in the frequency of scans ordered for a specific indication [9]. There was also a study about outpatient MRIs at a university hospital referred by primary care physicians. It revealed 23 per cent of the 175 examinations to be inappropriate. Most of the inappropriate examinations were in the group of shoulder and lumbar spine MRIs [5]. In another study, referrals for MRI examinations from various hospitals and clinics performing MRI in the area of Stockholm, Sweden, were surveyed. Nine per cent of the MRIs were deemed inappropriate [7].

Our study is an audit from a university hospital. We analysed both the referrals and the corresponding patient files in order to have the same information as the referring physician had while requesting the MRI. In our hospital, MRI examinations are mostly requested by specialists or residents from different departments or outpatient clinics of the hospital itself. Each referral for MRI is also checked by a radiologist before the actual examination in the context of planning the protocol, and the corresponding clinical patient files can usually be evaluated if necessary. At this point, clinicians may be guided and inappropriate referrals may be returned, but these referrals have not been registered. These practices may have contributed partly to the relatively low level of inappropriate examinations.

There are also reports of variable levels of justification of CT scans [10–13]. Our previous study revealed 30 per cent of unjustified CT examinations in young patients [14]. The interventions introduced in 2006 after that study—e.g., distribution of referral guidelines recommended by the EC and

education on indications of different examinations—may also have contributed to the results of the present study. The experience and training of the physicians on the appropriate use of imaging are important ways to improve appropriateness [15]. The referral criteria recommended by the EC have been accepted in Finland and have been translated into Finnish. They were in use in 2007.

According to one study, referring physicians perceive the usefulness of high-cost diagnostic imaging to be lower in unexplained complaints compared to specific diseases [16]. Most of our patients with appropriate examinations seemed to have clear indications for the examinations. MRI is a relatively new method, with rapid advances in technology, and it is used for a growing group of diseases and conditions. We realise that in addition to local habits, resources may be variable. Nevertheless, it would be essential to have clearly specified criteria for the everyday use of MRI for both referring practitioners and radiologists. It would also be important to study the appropriateness of MRI examinations in different kinds of hospitals and clinics. It might reveal the actual level of inappropriate examinations and the variable good or problematic practices that may impact appropriateness.

There are weaknesses in the present study. It is a survey from only one university hospital. We also included only five different types of MRIs in the study and the number of patients in each group is not very high. We did not measure the impact of the referral habits of the requesting physicians or the admission habits of the radiologists separately, either.

In conclusion, seven per cent of the MRI examinations analysed were inappropriate at a university hospital. Although the number was not high, financial issues and the growing number of patients referred for MRI are of concern. Education and regular use of up-to-date referral guidelines by the referring practitioners and the staff of the department of radiology could help to further improve appropriateness.

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