International Day of Radiology 2014
Interview on brain imaging
Iceland / Dr. Ólafur Kjartansson

The ESR spoke to Dr. Ólafur Kjartansson, a radiologist at the National University Hospital of Iceland Landspitali, Reykjavik, about the resources that are available for brain imaging in this small country and how they are put to use.

European Society of Radiology: Imaging is best known for its ability to detect and diagnose diseases. What kind of brain diseases can imaging help to detect and diagnose?
Ólafur Kjartansson: We can divide brain diseases from the imaging viewpoint into structural diseases of the brain, brain nerves, brain vascular diseases, functional diseases and neurodegenerative diseases, for example diseases that come with age, partly show macroscopic changes in the brain and for which firmer diagnosis can also be established by functional imaging methods. Brain imaging with computed tomography (CT) and magnetic resonance (MRI) is at its best when detecting diseases that cause specific macroscopic changes such as brain tumours, trauma, infection and inflammation. Functional MRI or diffusion-weighted imaging has a central role in everyday evaluation when imaging ischaemic diseases of the brain.

ESR: How useful is imaging in brain disease management? Does it improve the understanding of disease or improve patient prognosis?
OK: Modern brain imaging is very useful in imaging and managing patients with brain disease. For those of us who remember the time before CT imaging and have had the privilege to follow the development in our daily routine, the changes are almost unbelievable. From trying to image the shadow of a tumour by angiography or air encephalography to actually imaging the tumour itself and having means to suggest near-histologic origin, imaging has come a long way Brain imaging has a central role in detecting and deciding whether or not to operate or intervene when the patient has a brain tumour.
Imaging has also changed our understanding of the diseases, in choosing treatment and following up brain tumours and other diseases such as multiple sclerosis (MS). In the latter, imaging in regular intervals drives current treatment, and disease diagnosis can now be confirmed by imaging pattern criteria on MRI. In Iceland, we have not conducted trials that can answer the question of whether imaging improves our understanding of disease or improves patient prognosis.

ESR: What kind of technology and techniques do radiologists use to image the brain? Are there any specific techniques for particular diseases?
OK: In brain imaging, we use a number of imaging techniques that can be divided into two main categories: those using ionising radiation like CT, x-rays (angiography), single positron emission tomography (SPECT), positron emission tomography (PET) and PET/CT; and those using non-ionising radiation, like MRI and US. In general, CT is the main instrument in acute settings and when it comes to trauma, and is often the first in line because of its good accessibility for brain diseases. MRI would, in most cases, be the imaging of choice for brain diseases, but then you have to place the patient into an enclosed magnetic environment, which complicates the observation of the patient; the patient could be claustrophobic or have metal implants that are contraindicated, all points that have to be evaluated. CT angiography of brain vessels is sufficient to make the decision and serve as a road map for aneurysm surgery, but angiography continues to be the gold standard here, as well as in intervention and treatments in brain vasculature.

ESR: What is the difference between a radiologist and a radiographer? Who else is involved in performing brain imaging exams?

OK: Performing brain imaging is a joint project that requires more than one professional discipline, depending on which examination is being done. In Iceland, radiographers perform most of the exams and traditionally work with an imaging protocol set up by the radiologists, who later describe and interpret the examination. This reflects the working situation in Iceland today, but with the advent of PET, more complicated MRI equipment and special examinations, we will be seeing more input from many other professions such as physicists, psychologists, engineers and biochemists, and one must not forget the invaluable input from the anaesthetic department. In Iceland, a radiologist is a physician who subspecialises in radiology and has been trained in radiology and its subspecialties in another country, most often at a Scandinavian university hospital. The Icelandic radiographer today is a medical imaging university graduate from the University of Iceland and is trained there for all modalities.

ESR: How many patients undergo brain imaging exams in your country each year?
OK: At the end of 2013, the population of Iceland was 325,620, and out of that, 205,675 live in the greater Reykjavik area. A total of 9,109 CT brain scans and 3,946 MRI brain scans were performed last year. At Reykjavik University Hospital, which is equipped with two CT and two MRI machines, 5,084 individuals were examined in 6,027 CT brain examinations and 2,318 individuals were examined in 2,682 MRI brain examinations in 2013. That tells us that about 15% of patients examined with either CT or MRI of the brain had more than one examination that year in this institution.

ESR: Access to modern imaging equipment is important for brain imaging. Are hospitals in your country equipped to provide the necessary exams?
OK: In total, there is very good access to clinical medical imaging in Iceland. In the capital Reykjavik there is a dedicated angio laboratory, three whole-body MRI machines and two for extremities, five multidetector CT (MDCT) scanners, and two gamma cameras. SPECT CT will be installed this year. In Akureyri, there is one 1.5T MRI machine and one MDCT machine, and there are five CT scanners in the rest of the country. In Iceland, there is a total of four MRI and 11 CT scanners for clinical use. Hospitals are well equipped to provide the necessary clinical exams. We do not have PET, and those patients that are considered in need of PET are sent to Rigshospitalet in Copenhagen, Denmark, and there is also a contract to send patients in need of neurointervention to Karolinska in Stockholm, Sweden.

ESR: In many countries there are waiting lists for MRI exams. How long can patients typically expect to wait for an exam in your country?
OK: Yes, there is a waiting list for MRI in the greater Reykjavik area that varies and can extend up to two to three months. The workload for MRI clinical units is part of the explanation, but for patients that really need a brain imaging exam sooner rather than later, there is and should not be any waiting list. There is practically no waiting list for CT or US.

ESR: As the global population gets older, the risk of developing neurocognitive and neurodegenerative disorders increases. How can imaging help tackle this issue?
OK: Imaging has its place and can help in excluding other pathology, but this is a complex issue and a single imaging method or test is not available today. Structural MRI can show atrophy and shrinking in certain areas can be seen in patients who are considered to be more likely to progress to Alzheimer's disease (AD) than in healthy controls. Alzheimer's is characterised by a concentration of senile plaques, neurofibrillary tangles and neuronal death in these regions. They can also be identified with a PET scan that detects the beta amyloid that has previously been marked with isotope. One would expect this to be a good method to identify patients early in the course of the disease and to establish better prognosis by identifying the patient who will progress to AD. But it is not so simple, and it has been shown that beta amyloid increases with age, and therefore according to clinical protocols, amyloid PET does not identify dementia or predict the risk of progression to AD dementia. Structural MRI, SPECT and PET are the neuroimaging methods most widely used as biomarkers of neurodegeneration and dementia today, and will continue to be for the foreseeable

future. The most widely used technique is structural MRI but diffusion-weighted imaging (DWI)/ diffusion tensor imaging (DTI), magnetic resonance spectroscopy (MRS) and perfusion imaging are used as well.

ESR: Some imaging techniques, like x-ray and CT, use ionising radiation. What risk does this radiation pose to the patient and what kind of safety measures are in place to protect the patient?
OK: When it comes to brain CT, the expected clinical information most often outweighs the risks of radiation. Generally speaking, CT brain scans produce low exposure, in the region of one to two milliSieverts. At such low exposure levels it is difficult to determine the exact magnitude of risk. The risk increases with repeated and multiple examinations, and it is the duty of the radiologist and the doctors that order an imaging study to be appropriately observant. They should also follow up and use MRI exams, especially in children and younger individuals.

ESR: What kind of role can imaging play in preventing and predicting brain diseases?
OK: A good example of such a role is PET, which can show the collection beta amyloid plaques in an individual with progressive memory loss, a finding that can predict progression to Alzheimer's disease. Although the relationship has not been proven to be completely correct in clinical settings, it highlights the role that imaging could play in preventing and predicting brain disease. Other studies have addressed the relationship between the white matter lesions and brain volume loss on structural MRI and Alzheimer pathology markers, supporting the idea that vascular damage in association with increased brain atrophy is found in pre-dementia stages. Diagnosing Parkinson's disease in early stages is important to be able to discuss the prognosis and treatment with the patient. In his context, dopaminergic imaging with SPECT (DaTSCANN) has been useful.

ESR: In general, patients don't see the radiologist. A patient will discuss the image with the neurologist, neurosurgeon or oncologist. When they ask a question, they're often told: "I'm not a radiologist". Why don't radiologists discuss the image with the patient first?
OK: The environment the radiologist works in has changed much over the last 40 years, as well as the number exams and images that the radiologist has to view each day. To include a meeting and discussion with a patient into such a busy schedule would be very difficult to manage, expensive and time consuming. Before the patient comes to the examination, there is usually no prior relationship between the radiologist and patient, and that in itself can give an unwanted result. On the other hand, radiologists doing interventional work should get to know the patient, inform and explain the procedure and result, and do the follow-up on the patient. In some cases, if the patient or his/her family wishes to meet the radiologist and have an explanation for the images, that should not be a problem.

ESR: How expensive are radiological examinations to the health service and is there a risk that some of these examinations could be blocked by health technology assessment agencies deeming them to be not cost-effective? If so, how can patients help to ensure that these examinations are made available?
OK: In Iceland all healthcare is provided by the state. The healthcare budget is determined by the state budget and distributed among hospitals and other healthcare providers, both publicly and privately administrated. This means that the state pays for all clinical medical imaging examinations in Iceland and the provider of the service has to provide them and make them available when needed.
In Iceland, clinical imaging in the healthcare system is only done according to a written referral from a physician. The cost of each radiological and imaging service is negotiated between the private providers and the health authorities, but hospital radiology departments are run on a fixed budget. We do not provide the option of screening diseases with imaging in Iceland.