

International Day of Radiology 2014
Interview on brain imaging
Sweden / Prof. Elna-Marie Larsson



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To mark the International Day of Radiology's focus on brain imaging this year, Elna-Marie Larsson, professor of neuroradiology and staff neuroradiologist at Uppsala University Hospital, and visiting professor at Linköping University, Sweden, spoke to the ESR about the role of imaging in neurological care and the cooperation between radiologists and radiographers.

European Society of Radiology: Imaging is known for its ability to detect and diagnose diseases. What kind of brain diseases can imaging help to detect and diagnose?

Elna-Marie Larsson: The majority of brain diseases can be detected and diagnosed by computed tomography (CT) and magnetic resonance imaging (MRI), e.g. malformations, stroke, brain tumours, infection, inflammation and neurodegenerative disorders including dementia. Psychiatric diseases can, to a limited extent, be diagnosed with physiological or functional MRI methods.

ESR: How useful is imaging in brain disease management? Does it improve the understanding of disease or improve patient prognosis?

EML: Imaging is essential for the follow-up of treatment, in order to assess treatment effects and modify treatment in non-responders. This improves patient prognosis, e.g. change of treatment of brain tumours that do not respond. Another example is idiopathic normal pressure hydrocephalus (iNPH), which is heavily underdiagnosed and where 8 out of 10 patients treated with shunt insertion improve. It is estimated that at least one to two percent of all individuals under 65 years of age may suffer from this disorder. Morphological and physiological imaging of iNPH patients is increasing our understanding and knowledge of this disorder with unclear aetiology, and it helps us to detect the disorder in patients who may have been wrongly diagnosed with, for instance, Alzheimer's disease.

ESR: What kind of technology and techniques do radiologists use to image the brain? Are there any specific techniques for particular diseases?

EML: CT and MRI are the most common methods. They include morphological and physiological techniques, e.g. diffusion MRI, perfusion CT and perfusion MRI, functional MRI (fMRI), cortical activation studies and MR spectroscopy. MRI is the best method to image all brain diseases due to the high soft tissue contrast of the method, and also due to the great potential of physiological MR techniques. However, CT is the method of choice for acute subarachnoid haemorrhage and acute brain trauma. In all other cases, MRI is preferable, but CT is still performed a lot due to the limited availability of MR scanners. Some diseases, such as multiple sclerosis, cannot be detected at all on CT but are very visible on MRI.

Cerebral angiography is used for diagnostic evaluation of vascular disease in the brain, usually after detection with CT angiography or MR angiography. It is also used for endovascular treatment, for example the treatment of aneurysms and vascular malformations, and for acute thrombectomy in ischaemic stroke.

Radiologists increasingly use nuclear medicine methods such as positron emission tomography (PET) and single-photon emission computed tomography (SPECT), in collaboration with nuclear medicine specialists. PET/CT and PET/MRI, two combined methods, are also being used.

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

EML: A radiologist is a doctor responsible for the indications for imaging, selection of imaging protocol, optimisation of imaging methods, implementation of new methods, and the interpretation and reporting of imaging results. The radiologist also communicates with the referring clinician and

gives advice on further imaging investigations or other investigations to obtain a final diagnosis. The radiologist also participates in daily multidisciplinary conferences regarding patients with different diseases, contributes to the discussion and shows the images that have been obtained. The radiologist also performs the radiological interventions, endovascular coil treatment of cerebral aneurysms for example, and in that context also informs the patient before and after the procedure. A radiographer is a technician or nurse responsible for the imaging procedure and acquiring the images, in other words they operate the CT, MR scanner and angiography equipment. The radiographer also plans exams, talks to patients and informs them about the procedure. The radiographer is responsible for the image quality of each exam and performs some image analysis post-processing tasks. The radiographer injects contrast agent intravenously in Sweden and other countries, but not in all countries.

A physicist is necessary for the optimal handling and quality control of CT and MR scanners, to help with the optimisation of MR protocols and designing of new pulse sequences in MR.

ESR: How many patients undergo brain imaging exams in your country each year?

EML: In 2008, 650,000 CT brain exams were performed in Sweden. I would guess now approximately 900,000 a year, but I do not know the exact number. 30,000 MRI brain exams were performed in 2013 at the five university hospitals that have departments of neurosurgery. I would estimate that around 100,000 are performed in total in Sweden, but again I do not know the exact number. I would estimate that about 2,000 diagnostic cerebral angiography exams and approximately 1,500 neuroradiological endovascular interventions are carried out each year.

ESR: Access to modern imaging equipment is important for brain imaging. Are hospitals in your country equipped to provide the necessary exams?

EML: CT is available but there are too few MR scanners, also in university hospitals. Cerebral angiography is only performed at university hospitals.

ESR: In many countries there are waiting lists for MRI exams. How long can patients typically expect to wait for an exam in Sweden?

EML: That varies a lot depending on the hospital. For MRI of the brain, it is between within the same day (acute cases) to three months, sometimes longer. For CT, the waiting list usually ranges from only a few days to two weeks.

ESR: As the global population gets older, the risk of developing neurocognitive and neurodegenerative disorders increases. How can imaging help to tackle this issue?

EML: CT and MRI are really useful for differential diagnosis and for the support of different neurocognitive and neurodegenerative disorders. This helps treatment decisions and planning of care.

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?

EML: CT has improved a lot lately with the manufacturers providing reconstruction methods allowing much lower radiation doses to be used during scanning. For adults, CT of the brain has a very low risk. Young children should not undergo many CT brain scans and MRI is preferable in this case. High radiation doses can induce cancer and also benign tumours, or meningiomas. Some studies have indicated that cognitive effects can be seen after radiation of the brain in young children. Cataract is a well-known effect of high radiation doses to the lens of the eye.

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?

EML: Traditionally, the radiologist does not inform the patient about imaging findings, since the patient always wants to know how findings will be treated, and the radiologist is not in charge of

treatment and does not know all treatment options – except for interventional neuroradiology, where the neuroradiologist often informs the patient about findings and planned treatment, including risks.

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 (especially in relation to screening)? If so, how can patients help to ensure that these examinations are made available?

EML: The radiological examinations are cheap in comparison with many other costs in healthcare and can save money by providing a diagnosis instead of making the patient wait in a ward. Treatment monitoring also saves money, since inefficient and expensive treatment can be stopped.



***Elna-Marie Larsson** is professor of neuroradiology and staff neuroradiologist at Uppsala University and Uppsala University Hospital, Sweden. She is also visiting professor at Linköping University, Sweden. Currently, she is researching advanced cerebral MR imaging of the brain with applications in dementia, brain tumours and other diseases. Her clinical activity includes CT and MRI of the brain, spine, and ear, nose and throat. She has vast experience of teaching, both nationally and internationally, with an emphasis on MRI and neuroradiology. She has organised several MRI and neuroradiology courses. She has also published 124 papers in peer-reviewed scientific journals and 21 articles and textbook chapters. She is past president of the European Society of Magnetic Resonance in Medicine and Biology (ESMRMB), and has been president of the Swedish Society of Neuroradiology (SFNR), the Nordic Society of Neuroradiology (NSNR), and the Danish Society for Medical Magnetic Resonance (DSMMR).*