Research Article

7T MRI: the future of MR imaging

R K Tripuraneni[1*], Om Tavri[2], Madanman Mohan[3], Srikanth R M[4]

[1]Assistant Professor, Konaseema Institute of Medical Sciences, Amalapuram, East Godavari district, Andhra Pradesh, INDIA.
[2,3]Professor, [4]Asssociate Professor, Dr. D.Y. Patil University, Navi Mumbai, Maharashtra, INDIA.
Email: rajeshtripuraneni@hotmail.com

Abstract

7-Tesla (T) scanner is the latest apex in the rapidly changing development of magnetic resonance imaging (MRI), a technique that makes three-dimensional images of internal organs. The 7-Tesla's ultra-strong magnet about 140,000 times as strong as the Earth's magnetic field— yields spectacular images of the human brain at a resolution of about 1/5 of a millimetre.
Keywords: Magnetic Resonance Imaging, imaging techniques.

***Address for Correspondence:**
Dr. R. K. Tripuraneni, Assistant Professor, Konaseema Institute of Medical Sciences, Amalapuram, East Godavari district, Andhra Pradesh, INDIA.
Email: rajeshtripuraneni@hotmail.com
Received Date: 12/11/2014 Accepted Date: 21/11/2014

Access this article online	
Quick Response Code:	Website: www.statperson.com
	DOI:22 November 2014

INTRODUCTION

Since the introduction of magnetic resonance imaging (MRI) into clinical practice in the late 1970s, it has undergone multiple phases of development and technical improvements, beginning with 0.6T systems in the late 1970s, followed by 1.5T scanners in the mid 1980s, which today still account for 90% of the existing machines. In 2000/2001 3T systems were introduced for clinical diagnosis and have now become a standard diagnostic tool.[1] Recently, clinical MRI systems with a field strength of 7 Tesla have become available for clinical research in a small number of academic institutions.

DISCUSSION

The 7T system provides a quantum leap in imaging sensitivity, being 140,000 times stronger than the Earth's magnetic field, enabling incredibly detailed images of human anatomy down to the cellular level," says Professor Reutens. Among the advantages of 7-tesla MRI is the gain in signal-to-noise ratio, which enhances image quality by decreasing voxel size, said Dr. Christopher Hess. The advance translates into an approximately 15% reduction in voxel volume at 7-tesla MRI versus 3-tesla scanning. Another advantage that is often overlooked is enhanced tissue contrast, and 7-tesla MRI also greatly improves spectral resolution in neuroradiology applications.[2] The improved 7 Tesla technology allowed researchers to make highly-improved, detailed images of patients' brain tissue, especially the portion responsible for causing epilepsy. The clearer MRI images allowed Henry and his colleagues to more accurately find scar tissue associated with temporal lobe epilepsy. Accurately locating this scarring is critical because if medications fail to control epileptic seizures, it's often possible for highly-trained neurosurgeons to remove scars from the brain in order to stop the seizures. The healthy parts of the brain left untouched, and actually begin to function better after seizures stop. It's sort of like reading fine print with a magnifying glass versus the naked eye. The possibility of using 7 Tesla MRI to find brain lesions that were missed on current brain scans is likely to be very helpful in epilepsy and many other conditions.[3] 7 Tesla scanner can be more beneficial to image blood vessels with a diameter of 100 micrometer (one-tenth of a millimeter) to get more insight into small vessel disease, a rela-tively new concept in the study of cerebrovascular diseases. Most cerebrovascular diseases (about 60-70%) are caused by vessel obstructions (thrombosis), which may be due to atherosclerosis or impaired blood clotting, remaining cases of cerebrovascular disease are assumed to be due to

How to site this article: R K Tripuraneni, Om Tavri, Madanman Mohan, Srikanth R M. 7T MRI: the future of MR imaging. *International Journal of Recent Trends in Science and Technology* November 2014; 13(1): 197-199 http://www.statperson.com (accessed 24 November 2014).

small vessel disease. Prof. Willem Mali wants to use the 7-Tesla scanner to detect breast cancer, distinguish between benign and malignant disease, and precisely the location of the tumor so that surgeons know where to go.[4.] High field MR (plaque) imaging with 7 Tesla may allow plaque characterization and localization of cerebral damage with a higher resolution and more detail than imaging at lower field strengths. For instance, not only obvious cerebral ischemic lesions can be found, but also microbleeds, micro-infarcts and clinically silent ischemic lesions can be visualized, currently not possible with 1.5 Tesla or 3 Tesla.Recent reports demonstrated the use of UHF MRI at 7 T for brain imaging and showed relevant diagnostic benefits for brain tumors, cerebral malformations, Parkinsons's disease and multiple sclerosis[5]. Time flight MR angiography at 7T shows clear delineation of the perforating (or lenticulostriate) branches from the anterior and medial cerebral artery. These perforating arteries can be a more direct biomarker for cerebral small vessel disease.[6] Non-invasive assessment of the perforating arteries of the PCoA together with the anterior choroidal artery and the perforating arteries of the P1 at 7 Tesla may increase our understanding of infarcts in the deep brain structures supplied by these arteries.[6]

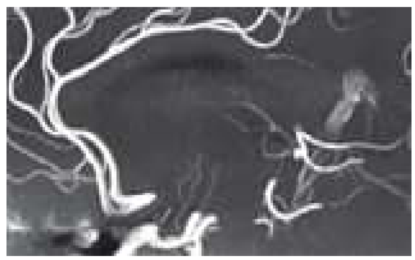

Figure 1: Time of flight angiography image of the posterior communicating artery with two perforating branches, sagittal slab maximum intensity projection (thickness 10 mm)

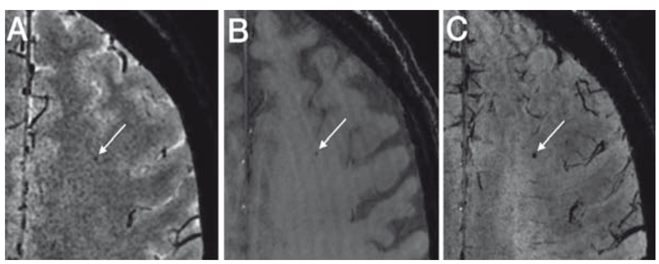

Figure 2: [**A**] The 1.5T scan shows a hypointense lesion (arrow) which can hardly be distinguished from noise and was not scored as a microbleed. On both the first echo image [**B**] and the second echo image [**C**] of the 7T scan this hypointense lesion is visible as a typical microbleed, showing enlargement at the second echo time due to the blooming Effect This lesion was scored as a microbleed by both observers.

The summation of the MIP and the min IP of the first echo image gives an image in which both the arteries and the microbleeds can be visualised. The first echo utilizes the strong paramagnetic effect of haemosiderin to obtain large contrast between microbleeds and the surrounding tissue on the first echo image, even in the presence of paramagnetic ferritin. The second echo enables visualization of smaller microbleeds than the first echo, as the blooming effect enlarges the observed size of the microbleeds at the second echo image. Furthermore, additional information about the relation between both arteries and microbleeds as well as veins and microbleeds can be obtained from this scan. Visualization of microbleeds and information about their relation with arteries and veins can be useful for future studies investigating the etiology, prevalence or prognostic value of cerebral microbleeds.[6]

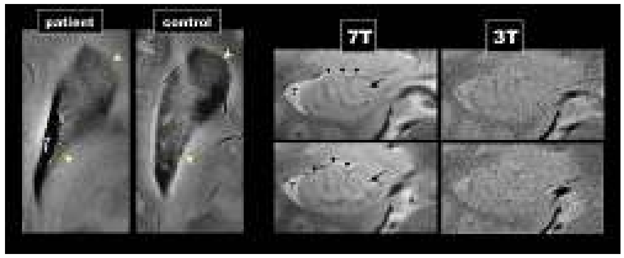

Figure 3: High resolution imaging using 7 tesla MRI Images on the left show atrophy and iron accumulation within the right basal ganglia of a patient with an atypical movement disorder compared to a normal control subject Images on the right compares the right hippocampus of a patient with epilepsy acquired using 7 tesla (left) and 3 tesla (right) MRI

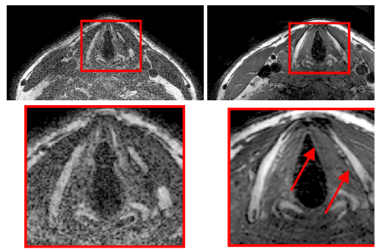

Figure 4: Larynx and vocal cords at 3T and 7T, in plane resolution Left: 3T, Right: 7T.[7]

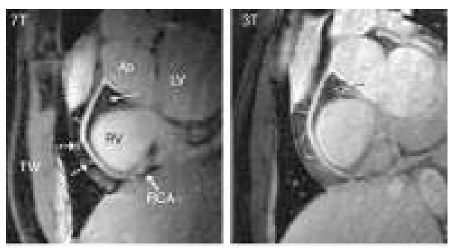

Figure 5: Right coronary artery images in a healthy 26-year-old male show high visual vessel definition (dotted arrows) in the 7-tesla image (a) compared to 3 tesla (b).[8]

CONCLUSION

7 Tesla MRI looks promising to detect potential early biomarkers for cerebral small vessel disease. 7 Tesla MRI shows many benefits for the detailed imaging of brain structures and brain function and is very well tolerated by patients. As the availability of 7 Tesla systems increases, the use of 7T for clinical research will also increase. This will improve our knowledge of neurologic and neurodegenerative diseases. There is lot of research happening to use 7T for musculoskeletal applications.

ACKNOWLEDGEMENTS

We acknowledge the love and support of our families, friends and our medical colleges.

REFERENCES

1. Subjective acceptance of 7 Tesla MRI for human imaging Jens M. Theysohn· Stefan Maderwald; Oliver Kraff· Christoph Moenninghoff · Mark E. Ladd; Susanne C. Ladd.
2. Aunt Minnie.
3. U of M researchers use improved brain imaging techniques; discover a better approach to diagnosing epilepsy- Health Sciences Academic Health Center.
4. UMC Utrecht.
5. Ultra high field MRI in human ischemic stroke-A7 Tesla study: Vince I. Madai, Federico C. Von Samson Himmelstjernal.
6. Imaging cerebral small vessel disease at 7 Tesla MRI Mandy M.A. Conijn.
7. 7T Head and Neck Imaging Research participants: J.J. Bluemink, C. Knegt, M.E.P. Philippens, C. Terhaard, C.P.J. Raaijmakers, J.J.W. Lagendijk, C.A.T. van den Berg.
8. 7T MRI matches 3T in right coronary artery imaging By Wayne Forrest, AuntMinnieEurope.com staff writer.

Source of Support: None Declared
Conflict of Interest: None Declared