Journal of Brain Research

Short Communication Open Access

Brain Tissue Contrast: Ct Versus Mri

Ramya Balakrishnan*

Department of Neuroscience, The University of Edinburgh, South Bridge, Edinburgh EH8 9YL, United Kingdom

Introduction

Medical images aim to provide adequate structural information to diagnose abnormal conditions and aid in therapeutic procedures. Computed tomography (CT) and Magnetic Resonance Imaging (MRI) are widely used imaging tools for diagnostic purposes and clinical research. These imaging modalities are complementary to each other. However, image quality of CT and MRI greatly varies. For instance, same level of visibility cannot be achieved for white matter displayed on CT and MRI. In 1969, Kurt Rossmann who was a pioneer in modern x-ray imaging research described image quality as that attribute of that image which affects the certainty with which diagnostically useful detail can be detected visually by the radiologist' [1]. A high-quality image can represent the anatomy of the brain clearly. Quality of an image can be described in terms of contrast, spatial resolution, noise, and artefacts [2]. Contrast is defined as 'the separation between the darkest and brightest areas of the image' [3]. In this article, brain tissue contrast exhibited by CT and MRI is discussed in detail. It is important to evaluate the level of contrast provided by CT and MRI for soft and hard tissues of brain, and how human eye perceive these images. An understanding about these concepts helps in choosing the right imaging modality to observe a particular brain tissue.

Prognosis

Human eye can identify an object in relation to its immediate background. The visual ability to recognize an object is determined by this ability rather than overall features of the total image. Brain image will be displayed with maximum level of accuracy if the contrast of the brain image is adequate. The degree of contrast represented in the brain image depends on the characteristics of the imaging system and the structure imaged. CT does not display same level of contrast for soft tissue and hard tissue of the brain. In CT scan, tissues with high density are displayed brighter relative to the low-density tissues. Hence, CT can provide better image contrast only when there is greater difference between dark and light areas of the image [4]. The colour scale of CT is a grey shade scale ranging from black to white. Hounsfield scale is used to represent the brain tissues on CT. Zero Hounsfield unit (HU) is assigned for water. Tissues that are denser than water are given positive HU values and less dense tissues are given negative HU values. For instance, air having – 1000 HU which appears black on CT and compact bone having +1000 HU appears white on CT. Brain soft tissues on CT have a HU value closer to water; for instance, grey matter having 25HU and white matter having 35HU. Since, the HUs assigned for grey and white matter are in a narrow range, differentiation of grey and white matter cannot be achieved precisely on CT. When tissues with similar density are displayed on a CT, human eye finds it difficult to discriminate the tissues. Because, the contrast is not sufficient (Figure 1).

In CT, principle source of contrast is provided by differences in physical density whereas, in MRI several sources provide contrast. Tissue contrast on brain MR images are based on the signals sent by the tissues whereas CT uses external to provide contrast [5]. Soft tissue contrast of MRI is superior over other imaging modalities.

The unique feature of MRI is that it can image several different

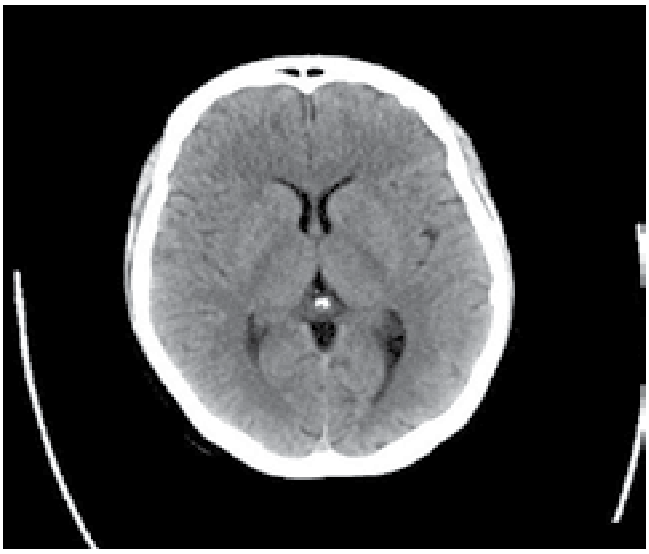

Figure 1: Axial non contrast normal head CT from a 26 years old female patient. Soft tissue contrast is not adequate to distinguish grey and white matter from this CT images. Hence, border of white and grey matter cannot be delineated accurately.

tissue characteristics such as proton density, T1, and T2 with excellent contrast which is not depended on single physical characteristic of tissue (density of the tissues) as in CT. If a particular area of a brain is not displayed clearly in one tissue characteristic, it is possible to view the same structure using other tissue characteristics in MRI whereas, in CT apart from tissue density other tissue characteristics cannot be used for imaging. T1 and T2 values are different for different tissues. On T1 weighted image melanin, protein rich fluid, fat, flowing blood appear bright and on T2 weighted image low proton density, fibrous tissue, deoxyhaemoglobin, methaemoglobin (intracellular), iron, ferritin, hemosiderin appears dark. In MRI, soft tissue contrast is provided by the differences in the MR signal which in turn depends on the T1, T2, and proton density of the tissue and imaging parameters. The differences between the T1 and T2 of white matter and grey matter provide superior image contrast between grey and white matter (Figure 2). Repetition time and echo time can be adjusted to obtain a particular contrast However, MRI fails to represent bony structures clearly.

***Corresponding author:** Ramya Balakrishnan, Department of Neuroscience, The University of Edinburgh, South Bridge, Edinburgh EH8 9YL, United Kingdom, E-mail: balakrishnanramya277@gmail.com

Received November 08, 2019; **Accepted** November 22, 2019; **Published** November 29, 2019

Citation: Balakrishnan R (2019) Brain Tissue Contrast: Ct Versus Mri. J Brain Res 2: 110.

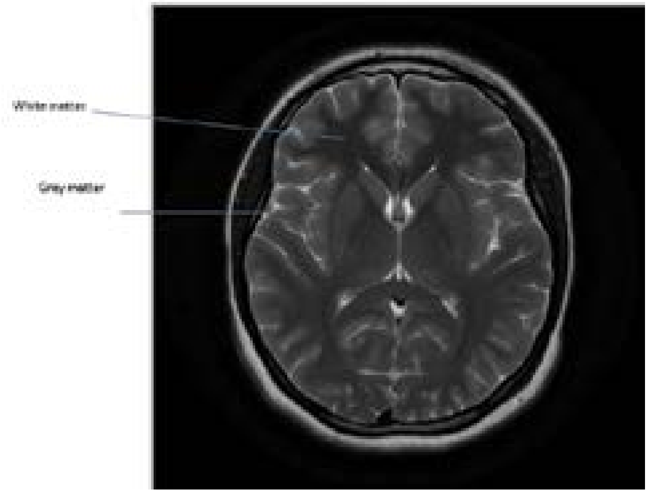

Figure 2: T2 axial MRI of a 20 years old female patient. White matter Tract can be clearly distinguished from grey matter.

In MR scan, Mineralised bone do not provide any signal during the image acquisition procedure [6]. Hence, bony structure such as skull bone appears black on MRI. Composition of the human skeletal system contains 50%-70% minerals (Phosphorus and Calcium), 20%-40% organic matrix, and 5%-10% water [7]. The principle behind MRI is the interaction between external magnetic field and an atomic particle which contains a spin, i.e. nuclear spin of proton. Protons of hydrogen atoms are used to represent an anatomical structure in MRI. The reason for using the protons of hydrogen atoms is that 80% of the human body contains water abundantly. Water contain two hydrogen atoms. If we look at the composition of bone, bone contains only 5%-10% of water. Because of less water in the bone, bone fails to send signal. To obtain a better contrast MR image, the organ of interest should contain sufficient hydrogen atoms. Hydrogen nuclear magnetic resonance signals are necessary to image a particular anatomical structure.

Hard tissues are displayed with better contrast on CT.X – rays are passed through various tissues of a particular part of the body. Based on the density of the tissues x rays will either attenuate or pass through the tissues. Dense structures such as bone will attenuate the x- rays. Advantages of CT in relation to representation of hard tissue are: sensitive to calcified structures (Bone), anatomy of the bone can be viewed clearly (example: base of skull, vertebrae). CT provides good quality image of surface anatomy (surface portion of skull). Structures such as base of skull, jaw, sinus, nasal cavity, and middle ear are clearly viewed with better tissue CT. Since, CT provides detailed information about the bone density it is also used as a diagnostic tool along with DEXA.

Conclusion

The contrast of soft tissues of brain provided by MRI is superior over CT. Hence, MRI is generally used to evaluate various pathological conditions of brain such as stroke, white matter lesions, brain tumours, Alzheimer's disease, multiple sclerosis. The borders of adjacent soft tissues can be clearly distinguished on MRI. For segmenting brain or regional parts of brain such as amygdala, hippocampus, MR images are preferred over CT. The soft tissue contrast provided by CT is not adequate to clearly distinguish the boundary of grey and white matter. However, calcified structures are displayed with better contrast comparing to MRI. Hence, CT is mainly used for acute injuries to brain or trauma, skull fracture, and bleeding in the brain.

References

1. Vyborny C (1997) Image quality and the clinical radiographic examination. RadioGraphics 17(2):479-498.
2. Goldman L (2007) Principles of CT: Radiation dose and image quality. J Nucl Med Technol 35(4):213-225.
3. Brightness, Contrast, Saturation, and Sharpness-Steve's Digicams. Steves-digicams.com. 2019 [cited 13 October 2019]. Available from: http://www.steves-digicams.com/knowledge-center/brightness-contrast-saturation-and-sharpness.html
4. Barnes J (1992) Characteristics and control of contrast in CT. Radio Graphics 12(4):825-837.
5. Magnetic Resonance Image Characteristics. Sprawls.org. 2019 [cited 13 October 2019]. Available from: http://www.sprawls.org/mripmt/MRI01/index.html
6. Goldbach-Mansky R, Woodburn J, Yao L, Lipsky P (2003) Magnetic resonance imaging in the evaluation of bone damage in rheumatoid arthritis: A more precise image or just a more expensive one? Arthritis & Rheumatism 48(3):585-589.
7. Clarke B (2008) Normal Bone Anatomy and Physiology. Clin J Am Soc Nephrol 3: S131-S139.