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Experience Report

Physical Bases Employed in the MRI Based on the Morphology of Tropical Fruits study: An Experience Report

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Abstract: Magnetic Resonance Imaging (MRI) is an exam that portrays morphological structures through high-definition images using a magnetic field. Understanding the physical basis of MRI represents a challenge for students in diagnostic imaging, as it involves advanced and complex technology. Here, we discuss image acquisition parameters, demonstrating advantages and disadvantages in using different values for each variable addressed and their impact on the quality and resolution of images obtained from the morphological study of tropical fruits. Based on the analysis of images of fruits submitted to MR scanning, we investigated the advantages and disadvantages of using different values for the field of view, slice thickness, matrix, and the use of different weights for scanning, measuring the resolution and quality of the images obtained. It was found that the use of fruit scanning represents an excellent tool for the development of students in radiodiagnosis, aiming at understanding the parameters used in the protocols for acquiring MR equipment and optimizing the quality of images.

Keywords: Institutionalized Elderly; Respiratory Function; Mobility Limitation.

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1. Introduction

Nuclear Magnetic Resonance (NMR) is a diagnostic imaging exam that portrays organs and structures through high-definition images, using a magnetic field. The method does not use ionizing radiation because it uses electromagnetic energy and radiofrequency to acquire medical images [1, 2]. Magnetic resonance imaging (MRI) is one of the exams that offer higher quality images of the human body, including the brain, spine, cartilage, ligaments, joints, musculoskeletal system, abdominal organs, heart and blood vessels, among others. For more than 30 years, the method has been improving and becoming essential for several medical specialties. MRI produces non-invasive three-dimensional images, in addition to having excellent resolution [3].

This exam facilitates the diagnosis of numerous pathologies such as tumors, infections, malformations, ischemic and hemorrhagic strokes, cerebral aneurysms, venous thrombosis, hydrocephalus, herniated discs, joint injuries, in addition to allowing the investigation of the causes of seizures and epileptic seizures, for example. example. MRI is more sensitive than computed tomography, as it provides better visualization of lesions and allows the investigation of various pathologies, allowing assertive decision-making for the success of the therapeutic approaches adopted [4].

Magnetic Resonance Imaging is an imaging method, used in clinical practice and which is always in development. It can differentiate tissues and collect biochemical information and explore anatomical and functional aspects. Hydrogen nuclei, which have a charge and are in constant rotational motion (spin), produce small randomly oriented magnetic fields. When the nuclei are subjected to an external magnetic field of greater intensity, their magnetization vectors align in the same direction in rotational motion aligned with the external magnetic field, precession. The frequency of this rotational movement (Larmour frequency) is specific to the Hydrogen nucleus and varies according to the strength of the magnetic field, which is measured in Tesla.

The application of energy pulses or Radiofrequency (RF) pulses causes it to absorb energy and deviate its magnetization vector from the initial position. The absorbed energy is released by the core in the form of RF, as soon as the RF pulse is turned off, when its vector returns to its resting state, aligned with the external magnetic field of greater intensity. An MRI equipment is therefore composed of a magnet, measured in Tesla, gradient coils, an antenna coupled to an RF amplifier to stimulate the patient with RF pulses and a receiver to capture the signal emanated by the patient. A computer is needed to control the equipment and generate the images, which can be displayed statically, dynamically or in multiplanar reconstructions [5].

In T1-weighted MRI images, contrast between tissues is optimized when short echo time (TE) and repetition time (TR) are used. When it comes to anatomical images, fat is visualized with a hyperintense appearance (higher signal intensity) and water and liquids are hypointense (lower signal intensity). On the other hand, in T2-weighted images, there is a greater contrast ratio between tissues when using long TR and TE. For the anatomy of regions that concentrate a greater amount of liquid, it will be visualized with hypersignal (higher signal intensity), whereas fat will present hyposignal, that is, lower signal intensity [6].

Magnetic resonance imaging (MRI) is an imaging technique with high diagnostic capacity, with excellent spatial resolution, capable of providing extensive information with relevant clinical impact, without the use of ionizing radiation or iodinated contrast agents. For these reasons, MRI is now an indispensable imaging modality in the diagnosis and follow-up of multiple pathologies. Annually, several million MRI scans are performed worldwide, and it is expected that this number will continue to grow in view of the increase in the longevity of the population, combined with technical evolution and the expansion of the clinical applications of this technique [7].

Understanding the physical bases of the magnetic resonance technique is usually a challenge for students and professionals in diagnostic imaging, since it involves a very advanced and complex technology, from the point of view of physics and engineering. Thus, we aimed to verify the main characteristics of the images acquired (resolution and quality) from tropical fruits submitted to magnetic resonance scanning, correlating the results obtained and the physical bases inherent to the applied method, thus providing a better understanding of the applicability of the technique of diagnostic imaging.

2. Materials and methods

The present study is characterized by a descriptive survey with a qualitative approach, since it gathers data on the results verified during the analysis of magnetic resonance images of tropical fruits submitted to magnetic resonance scanning in Philips equipment, model Prodiva 1.5 Tesla. The production of data for image formation was possible using magnetic resonance signal capture coils, model and MKS coil. The research was accepted in the Scientific Initiation Program of the Centro Universitário Estácio do Ceará in partnership with the magnetic resonance service of Clínica Omnimagem, located in the city of Fortaleza - Ceará.

The instrument used for data collection was the PACS System database of the aforementioned clinic located in the central region of the capital of Ceará, through which we retrieved the images taken during the data acquisition period (August to October 2021) to carry out this research. The analysis of the results of the scans carried out consisted of investigating the advantages and disadvantages of using different protocols with variations in values for field of view (FOV), slice thickness (millimeters), image matrix, in addition to the use of different image weights (T1 and T2) evaluating the resolution and quality of the images obtained, information produced by them, in addition to the impact promoted by the application of protocol variations during the respective acquisitions.

3. Results

3.1 Application of Fields of View (FOV) variations

The tangerine fruit was scanned by magnetic resonance, using the same T2-weighted image acquisition protocol, varying only the size of the Field of View (FOV) in the technical protocol chosen for the acquisition of these images. We chose to acquire MR images with FOVs of 100, 200 and 300 millimeters (Figure 1A to 1C). We can observe that the smaller the applied FOV, the larger the magnetic resonance image of the studied sample is, and, in this way, the structures that compose it can be evaluated in more detail.

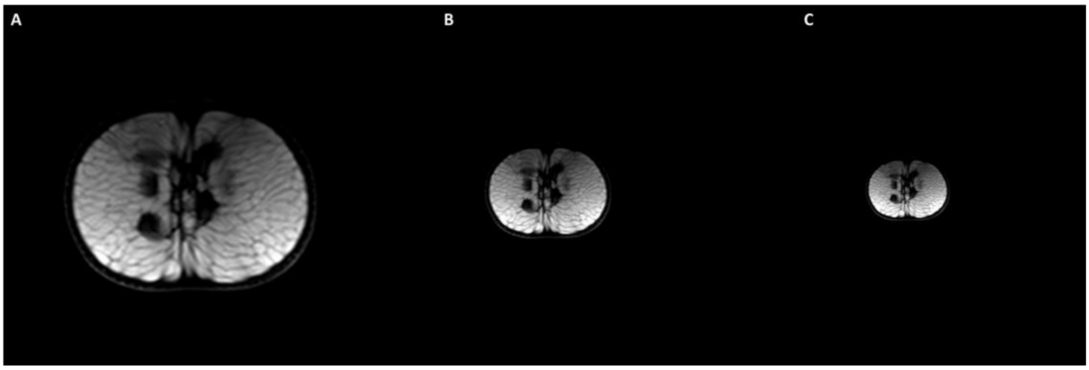

Figure 1. MRI Image of Tangerine fruit acquired under Field of View (FOV) of 100 (A), 200 (B) and 300 (C) millimeters, respectively.

3.2 Application of Cut Thickness variations

In a second moment of data acquisition, the tangerine fruit was scanned by magnetic resonance, still using the T1-weighted image acquisition protocol, varying only the slice thickness of the images to be acquired, in millimeters. We chose to acquire the MR images with a thickness of 1.5, 3.0 and 5.0 millimeters (Figure 2A to 2C). Through the analysis of these images, we can conclude that the smaller the thickness applied, the more details of the sample can be visualized through magnetic resonance imaging, despite the images having a lower signal-to-noise ratio (SNR) and promoting greater granulation. In this way, it is necessary to maintain the balance between slice thickness and RSR for adequate image quality to be presented in medical images.

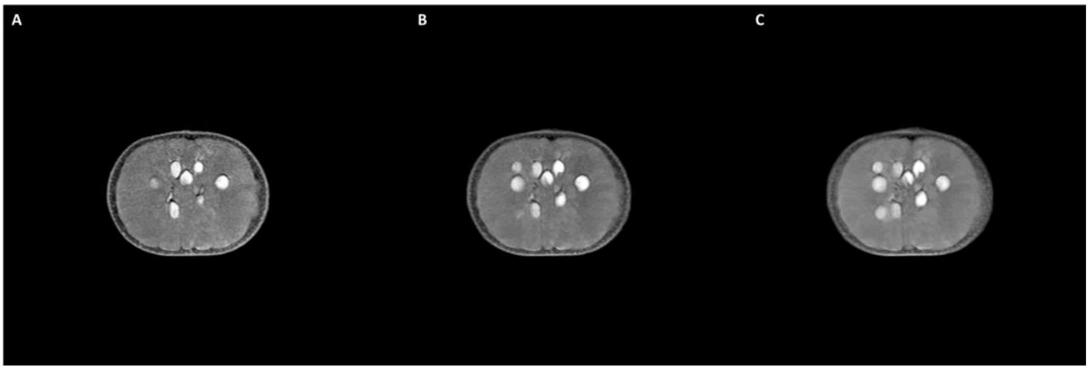

Figure 2. MRI Image of Tangerine fruit acquired under slice thickness of 1.5 (A), 3.0 (B) and 5.0 (C) millimeters, respectively.

3.3 Application of different MR Image Weights (T1 and T2)

In the third stage of image acquisition by magnetic resonance, the Pinha (Ata) fruit was scanned using a standard protocol with a field of view of 150 millimeters and a slice thickness of 3 millimeters. Images were acquired under T1 weighting, with low Repetition Time (TR) and Echo Time (TE), and T2, with high Repetition Time (TR) and Echo Time (TE) (Figure 3A and 3B).

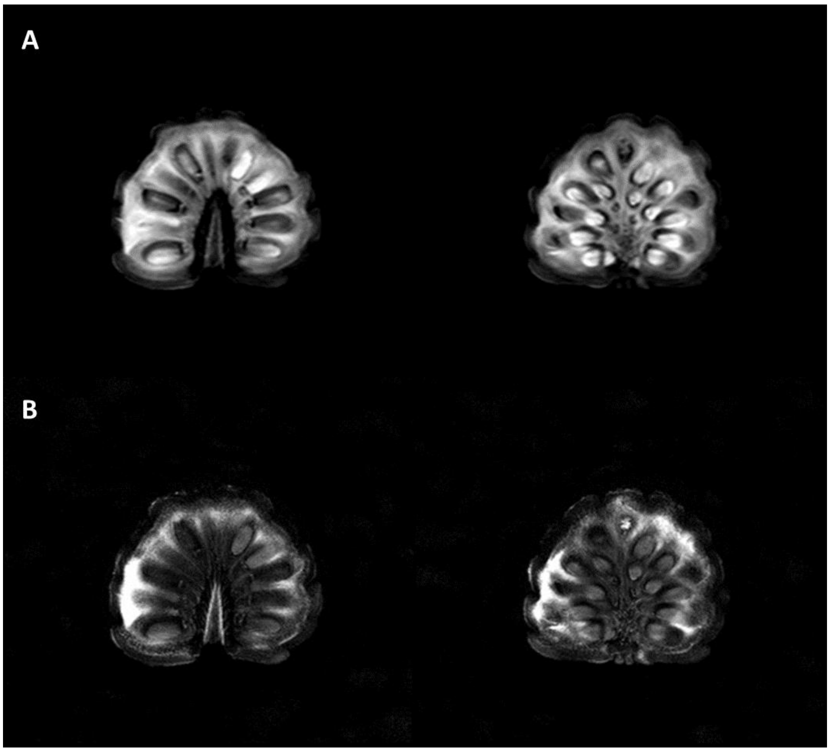

Figure 3. Magnetic resonance scanning of custard apple fruit (Ata) using standard protocol with 150 mm field of view and 3 mm slice thickness. Image acquired under T1 (A) and T2 (B) weighting (low Repetition Time - TR and Echo Time - TE).

We also scanned the Carambola fruit under T1 and T2 weighting (Figure 4A and 4B). We can see that on T1-weighted images there is hypersignal in regions rich in lipids (fat), more predominantly in the seeds and, more discreetly, in the fruit pulp. On the other hand, in T2-weighted images we have hyposignal in these more lipid areas (highlighted in T1 weighting) and display of hypersignal in regions rich in water, predominantly distributed throughout the entire region of the fruit pulp. When submitting the Banana fruit to scanning under T1 and T2 weightings (Figures 5A and 5B) we observed that there is more water in the peel region (T2 images) and more fat in the seeds and pulp region (T1 images).

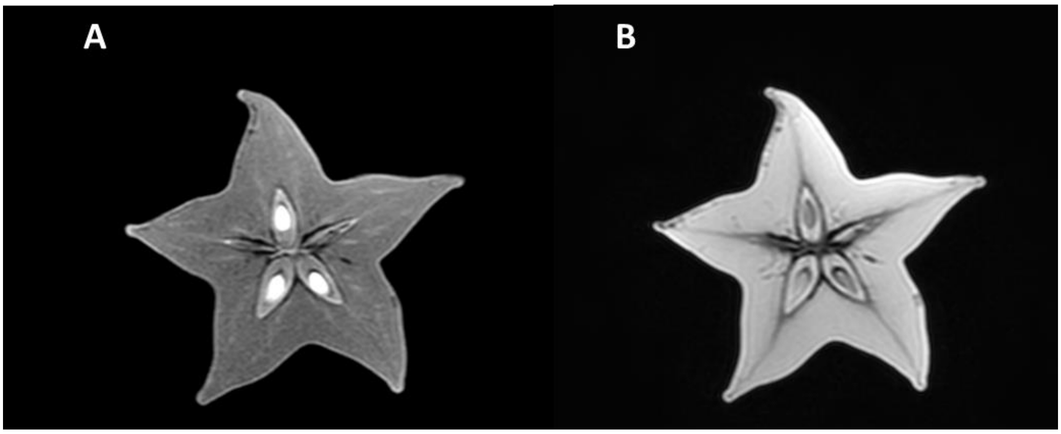

Figure 4. Magnetic resonance scanning of Carambola fruit. Image acquired under T1 (A) and T2 (B) weighting (low Repetition Time - TR and Echo Time - TE).

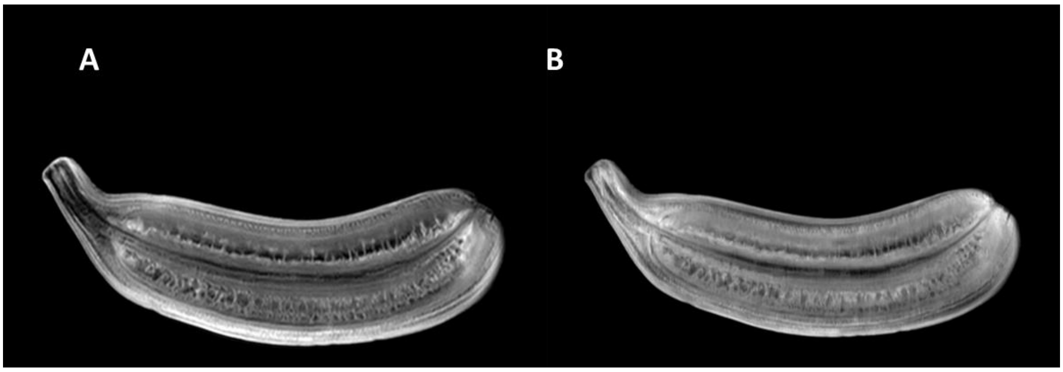

Figure 5. Magnetic resonance scanning of Banana fruit. Image acquired under T1 (A) and T2 (B) weighting (low Repetition Time - TR and Echo Time - TE).

3.4 Application of different Excitation Numbers (NSA/NEX)

In the fourth stage of magnetic resonance image acquisition, the pitaya fruit was scanned using a standard protocol, varying only the number of excitations (NSA/NEX). We used acquisitions with 3 and 7 of NSA (Figures 9 and 10). We can observe that in the images acquired with factor 7 of NSA there is better definition, the contours of the seeds are better visualized, when compared to the images acquired under factor 3 of NSA.

3.5 Application of different image reconstruction matrix

In the fifth stage of image acquisition by magnetic resonance, the Kiwi fruit was scanned using a standard protocol, varying only the value of the image reconstruction matrix. We used a reconstruction matrix of 256 and 800 (Figures 11 and 12). We can observe that in the images with a higher matrix (800) there is better definition, the contours of the kiwi seeds are better visualized, when compared to the images acquired under a low matrix, of 256.

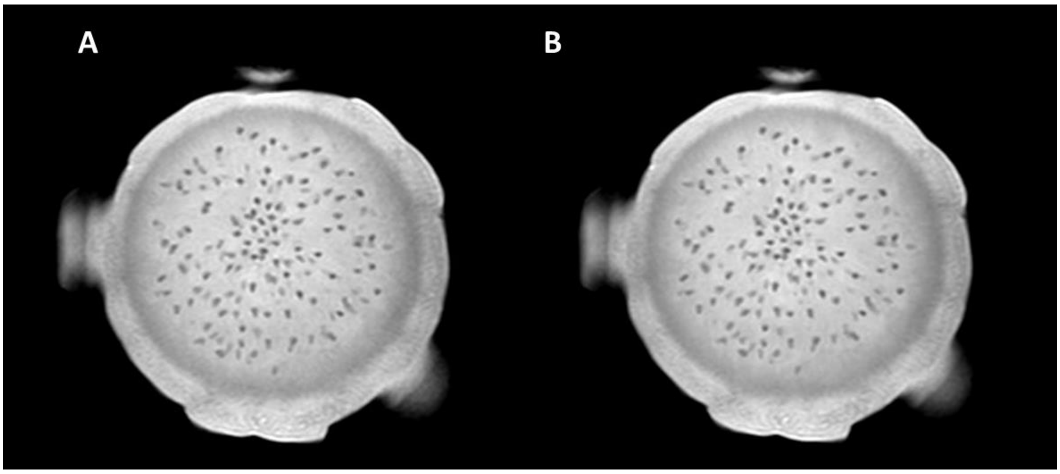

Figure 6. Magnetic resonance scanning of Pitaya acquired under T1 (A) and T2 (B) weighting and protocol using NSA factor 3 (A) and 7 (B).

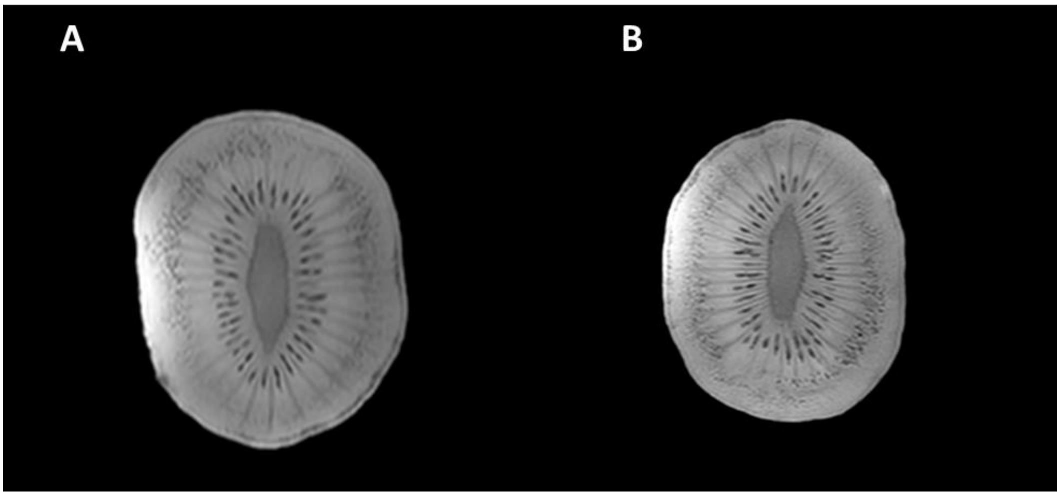

Figure 7. Kiwi magnetic resonance scan depicted under reconstruction matrix 256 (A) and 800 (B).

6. Conclusion

Through the results obtained, through variations in the techniques of protocols applied for the acquisition of magnetic resonance images, we can develop technical learning by promoting critical discussions about the main parameters used in the acquisition of these images, demonstrating the advantages and disadvantages of protocols adopted in services and centers of diagnostic imaging. It is also possible to verify the impact of these technical choices reflected in the quality and resolution of the images obtained, correlating these results and the physical bases inherent to the applied method, thus providing a better understanding of the applicability of the technique of this modality of radiodiagnosis.

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Supplementary Materials: None.

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