

T2 Mapping in Cardiac Magnetic Resonance Imaging: Study and Identification of Normal Parameters in a Sample of the Local Population

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Magnetic Resonance Imaging, Cardiac MRI, T2-Mapping, Normal T2-Mapping Values.

ABSTRACT

Mapping represents the most advanced technique for tissue characterization of myocardial tissue in magnetic resonance imaging, to the point that it has been considered a kind of 'in vivo biopsy' of myocardial tissues useful for the early diagnosis of any pathologies. The study aims to determine the normal range of T2-mapping values in a local population sample using a 1.5 Tesla magnet device. In magnetic resonance imaging, it is essential to define the normal range of T2 values during Mapping sequences on healthy individuals to identify early anomalies that may indicate the presence of potential cardiac pathologies such as myocarditis. The patients revealed to be healthy, as established by the complete examination carried out according to our protocol, showed normal biventricular ejection fraction, normal dimensions of the left and right ventricles, absence of edema in STIR sequences, and absence of LATE ENHANCEMENT in post-contrast sequences. Reference values for T2 can be influenced by the magnetic field strength (1.5/3T), gender, weight, heart rate, and age of the patient. The results revealed that the standard average value for T2 Mapping in a sample of the local healthy population is 30 ± 10 ms. The limitations of the study include longer acquisition times compared to other techniques and also include the limited size of the examined population sample.

INTRODUCTION

Nuclear Magnetic Resonance is an advanced radiology technique that generates three-dimensional images capable of studying the human body using magnetic fields, in this case, it will be useful for studying the heart muscle. Magnetic resonance imaging uses various sequences useful for diagnosis, but the sequence capable of diagnosing the most details in the cardiological field is Mapping. Mapping represents the most advanced technique for tissue characterization of myocardial tissue in magnetic resonance imaging, to the point that it has been considered a kind of 'in vivo biopsy' of myocardial tissues for the early diagnosis of any pathologies. It is important to know that Mapping offers precise details both in health and in pathology when there is an increase in the standard value that would indicate the presence of extracellular damage, as in the case of myocarditis edema. Advanced Cardiac Imaging techniques, such as T2-Mapping and during production. T2 Mapping, have proven to be invaluable tools in the standardized protocol as they have allowed us to identify normal values in healthy patients, thanks to their chromatic maps. The aim of the study is the identification of normal parameters in a sample of healthy local population Received:

date Accepted: date Published: date studied with the cardiac magnetic resonance T2-Mapping sequence.

MATERIALS AND METHODS

The research and data collection project began in March 2024 and ended definitively in September 2024. The study was done on the 1.5 Tesla SIEMENS magnet at the San Nicola Pellegrino hospital in the city of Trani. A sample of healthy subjects was included, comprising a representation of both sexes, in order to analyze the variations in normalization values between the different gender groups. T2 mapping is an advanced technique that provides detailed images in the pre-contrast phase. This technique is therefore indispensable for patients who are allergic to contrast agents or who present with renal insufficiency. In addition to the T2 mapping sequence, STIR and Late Enhancement sequences were included to ensure the absence of edema with greater certainty. T2-Mapping is particularly useful because it provides detailed color maps of the heart, allowing doctors to visualize abnormal areas more accurately and quickly. This technique not only improves the quality of diagnostic information, but also does so in a significantly shorter time frame than other diagnostic techniques, facilitating timely and targeted interventions.



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- **Sequence T2-Mapping:**

The most advanced technique for tissue characterization of myocardial tissue in magnetic resonance imaging, to the point that it has been considered a kind of 'in vivo biopsy' of myocardial tissues useful for the early diagnosis of any pathologies. (Fig.1)

- **Sequence STIR:**

The Short Time Inversion Recovery (STIR) (Fig.2) technique has a very short inversion time (TI) that allows for the nulling of signals from tissues with short longitudinal relaxation times (T1), such as fat. Therefore, the STIR sequence is used to diagnose the presence of edema.

- **Sequence LATE ENHANCEMENT:**

The scan is performed 10-20 minutes after the contrast injection to produce the so-called late gadolinium enhancement (LGE) (Fig.3), which allows for highly reproducible visualization of pathological myocardium.

Before undergoing the magnetic resonance imaging (MRI) examination, the patient fasted as recommended in the pre-exam preparation. After entering the diagnostic room, the doctor conducted a detailed clinical history, collecting information about the patient's medical history. To maximize the signal collected during the scan, a double coil (an essential tool in magnetic resonance imaging to improve sensitivity and resolution) was placed on the patient's body. For the patient's comfort and to reduce the impact of the noise generated by the MRI system, protective headphones and an emergency bell were provided. It is crucial for the patient to remain calm and relaxed throughout the entire examination. This not only helps obtain high-quality images but also ensures that the procedure proceeds without delays and within the expected timeframe. Proper patient management, along with clear and reassuring communication, is essential for the success of the diagnostic investigation.



Fig.1 (T2- MAPPING)

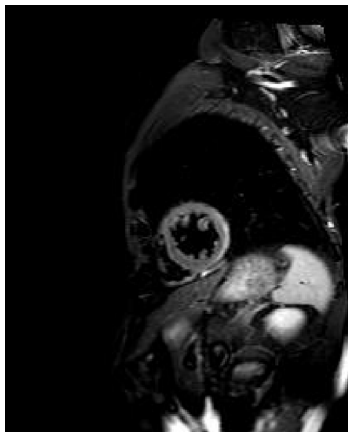


Fig.2 (STIR)

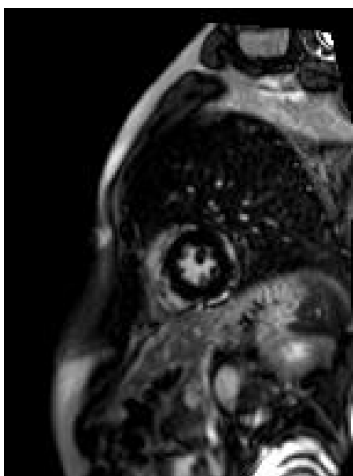


Fig.3 (LATE ENHANCEMENT)



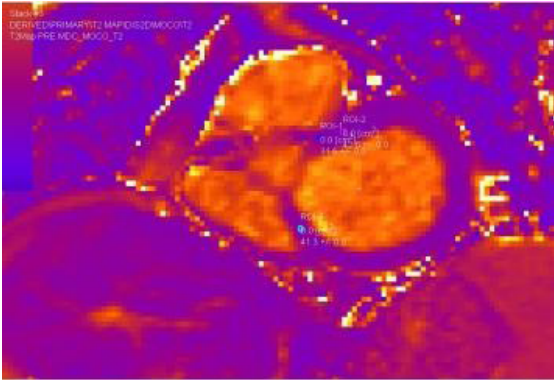


Fig.4
ROI positioned in the basal portion of the short axis plane of the cardiac muscle

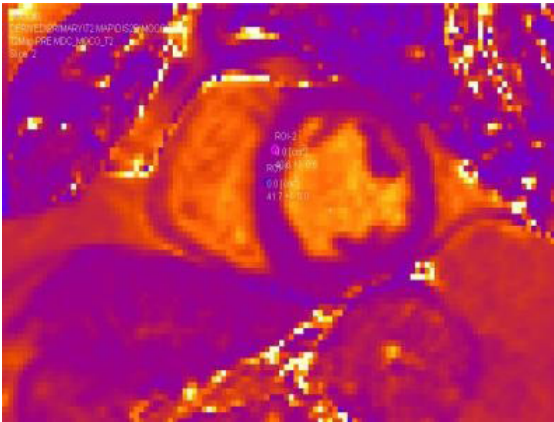


Fig.5
ROI positioned in the medial portion of the short axis plane of the cardiac muscle

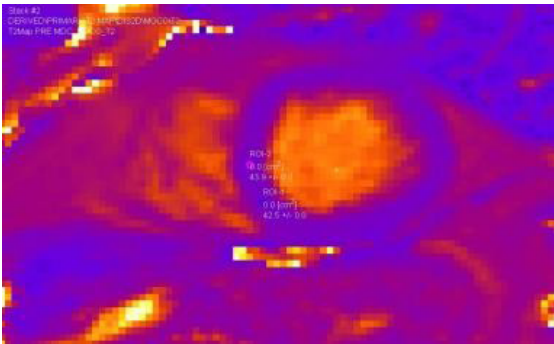


Fig.6
ROI positioned in the apical portion of the short axis plane of the cardiac muscle

RESULTS

After completing the examination with the standard protocol, T2 Mapping, STIR, and LATE EN HANCEMENT sequences were added. During post-processing, the normal T2 Mapping values were calculated for the interventricular septum at the basal, middle, and apical portions of the short-axis plane. The normal value was found to be 30-40ms with an uncertainty of 2-3ms. To calculate T2 Mapping, it is important to rely on its chromatic map (Fig.1), which can evaluate the values. Through the use of advanced color maps, it was possible to identify reference values that support a more accurate and precise diagnosis. The results obtained highlighted that the standard parameters for these techniques are not uniform, but depend on the type of equipment used and the power of the magnet, which can vary between 1.5 and 3 Tesla. In this case, for example, the reference values measured with the

SIEMENS magnet indicate that the T2-Mapping lies in a range of 30 +/- 10 ms, while the T2* Mapping lies between 10 and 20 ms because the patients who presented these values presented no pathology and a healthy myocardium. These normal values are determined by the interaction between the intensity of the magnetic field and the specific characteristics of the machine in use, which influence the precision of the measurements and the ability to distinguish different tissue properties. Therefore, the differences between the different MRI systems lead to normal values that cannot be applied universally, but are specific to each device. In order to define the value of 30 +/- 10 ms for T2 MAPPING and 10 +/- 20 ms for T2* MAPPING as normal, in addition to the 25 patients, one patient was analyzed who presented values different from the above, with acute-phase myocarditis. The edema in T2 STIR appears hyperintense at the level of the lateral wall

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corresponding to the inflammatory myocarditic process (Fig.3), and in T1 GRE post-contrast, the same area shows contrast enhancement (Fig.4). This patient showed high values corresponding to 60 ms, indicating pathology (Fig. 5).

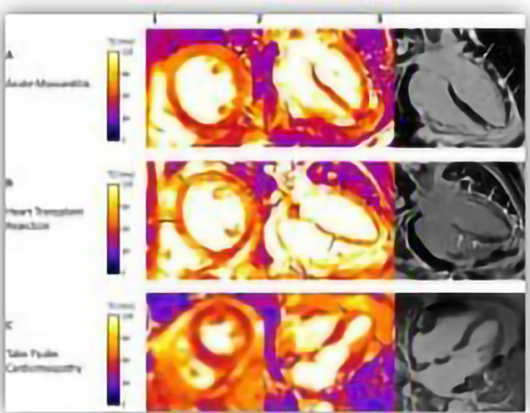
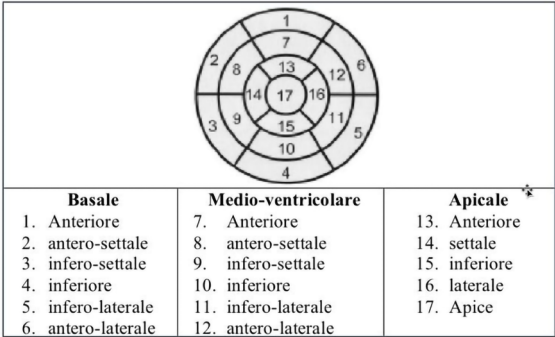


Figure 1. (T2 MAPPING)
Chromatic map to evaluate the normal value of the T2- Mapping.



(a)



(b)

Figure 2.
This is a figure. Schemes follow another format. If there are multiple panels, they should be listed as: (a) Correct patient positioning is crucial as it is important for performing an excellent examination. ; (b) Identification of the portion where the ROI was placed to calculate the T2 mapping value.

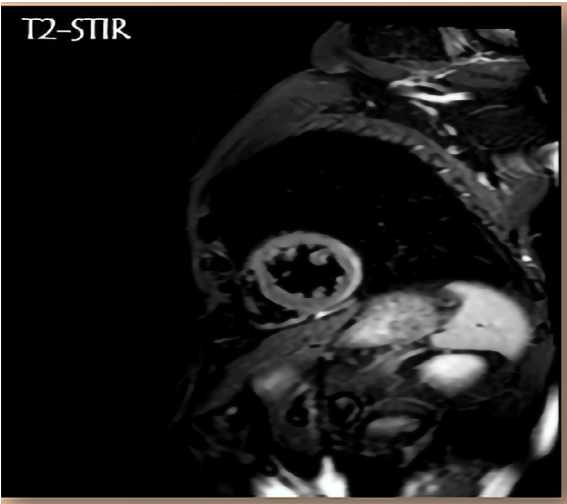


Figure 3.
The edema in T2 STIR appears hyperintense at the level of the lateral wall corresponding to the inflammatory myocarditic process,

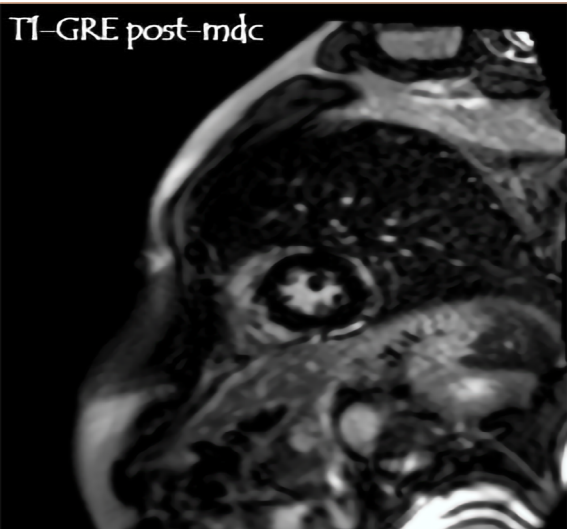


Figure 4.
T1 GRE post-contrast, the same area shows contrast enhancement.

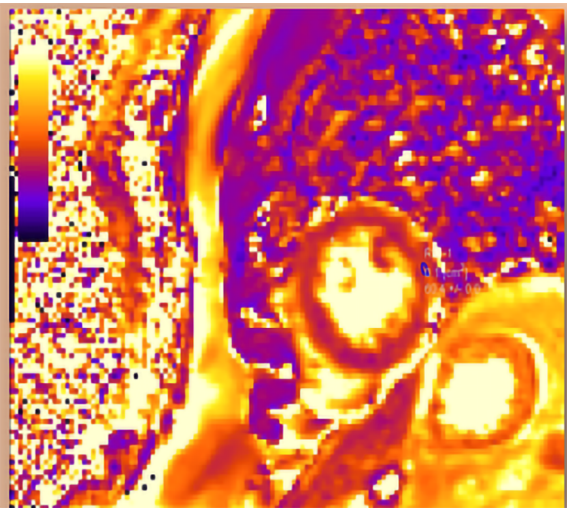


Figure 5.
Patient with T2 MAPPING value of 60 ms with acute phase myocarditis.

DISCUSSION

In order to analyze the patients, several data were taken into consideration: age, sex, body weight, height and heart rate. The heart rate of a healthy patient is within 65/70bpm. To analyze the study, 25 healthy patients were taken into consideration, of which 17 men and 8 women considered healthy because the test gave a negative result showing a normal bi-ejection fraction ventricle, normal dimensions of the left and right ventricles, absence of edema in the STIR sequences and absence of LATE ENHANCEMENT in post-medium sequences contrast. Values different from these could lead to potential pathologies, indeed values outside the 30-40ms range demonstrated pathology at the level of interventricular septum depending on the type of equipment used and the strength of the magnet. Mapping emerges as a cornerstone in the field of radiology, offering a detailed and accurate representation of healthy and pathological anatomical structures. The analysis of the local population using T2 MAPPING revealed that most patients, both men and women, are in good health. It is essential

to emphasize, however, that careful monitoring and timely diagnosis can significantly contribute to the overall well-being of patients, ensuring optimal management of their health conditions. Through detailed chromatic maps, it is possible to establish normal values that contribute to a clearer and more precise diagnosis. The results obtained, in fact, have shown that the reference values for these techniques are not universal but vary depending on the type of equipment used and the strength of the magnet, which can be 1.5 or 3 Tesla. The purpose of the thesis was to highlight the normal values in a sample of the local population so that values different from these could determine potential pathologies. Mapping emerges as a cornerstone in the field of radiology, offering a detailed and accurate representation of healthy and pathological anatomical structures.

CONCLUSIONS

To wrap up, our study has established that the normal T2-MAPPING parameter in a sample healthy population, is 30 +/- 10ms.

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