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Fundamental Sequence and Interpretation of Brain Magnetic Resonance

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Abstract: Brain magnetic resonance has mounted additionally how a totally treasured device to the prognosis from neurological diseases, because of is potential to supply wonderful element and characterization from Tissue.
This paper explained the physically Base from magnetic resonance imaging and the exclusive sequences 2nd hand in the brain imaging Protocol, with the goal from distribution the reader with the primary device to recognise brain imaging.

Keywords: magnetic resonance, brain, sequences, algorithm, atom.

I. INTRODUCTION

Magnetic resonance imaging (RM) Has state established how a Tool very valuable in diagnosis e Research from lot of the areas in Medicinal, thanks to its great efficiency excellent characterization soft tissue differentiation several the areas from the Body Next, the physically bases from magnetic resonance to explain, the different Basic sequences Second hand how a protocol in Brain images, is utility and the role from the imaging Half Contrast.

II. PHYSICALLY BASE FROM MAGNETIC RESONANCE

As we all know, matter is composed of atoms. These atoms have a nucleus where protons and neutrons are found, and a shell in which the electrons are located organized. Odd atoms of electrons have a positive excess commission in the nucleus (protons), is constant Be crazy on its axis however, a movement called tour [1-3].

This positive load from the in movement the proton generates an electric current those in constant motion generates a magnetic force magnetic field. Hence the proton Has is to possess magnetic setting up And Power to be considered how a small magnet [1, 4].

The hydrogen atom (most abundant in the human body) has the property described above, named spin or magnetic moment. However, inside any tissue that are these magnetic fields randomly oriented, each cancellation Various, the is Why tissue Do not to have Net Magnetism. What happens Self a tissue is matter to a magnetic field? Protons, be line up like little magnets on the outside magnetic field. They can be aligned parallel to the external magnetic field (This requires a lower energy level) or antiparallel to the magnetic field (need Moreover power to the This Scope).

The dominant orientation is the one that consumes less energy, therefore more protons want line tall in a parallel Direction. However, the difference in the number from protons aligned parallel versus antiparallel is Very small. An approximately calculation is done 10.000.007/10.000.000[1, 2, 4, 5]. This proton, in additive to forward a message same parallel or antiparallel a the magnetic setting up, movement around it however, a movement called precession, whose speed or frequency is decidedly through the intensity from the magnetic setting up to the with patience is matter.

That harder the magnetic setting up, the higher the precession frequency (W), which can be calculated from it LARMOR Equation, where is it B0 is the intensity from the external magnetic setting up (measured in Tesla or T) and ÿ is a gyromagnetic constant the is different for each element (the value for the hydrogen proton is 42.5 MHz / T).

$$w\ [Hz / MHz] = ÿB0\ [T]$$

Therefore, the precession frequency (W) is equal to the gyromagnetic constant times the intensity from the magnetic setting up. It is from Great meaning to knows the precession frequency in the generation of MRI images, whatever to be view after [1, 2, 4, 6, 7].

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The initial result of subjecting the patient to a magnetic field is the obtaining of a net magnetization, from of excess protons orienting parallel to the axis of the external magnetic field. Like this magnetization is in the direction of the field magnetic, it is called longitudinal magnetization. This magnetization longitudinal is used to obtain signals magnetic resonance imaging; nevertheless, does not provide information on the magnetic contrast of the tissues (which is what that interests us), so it is necessary to use short pulses of waves electromagnetic, which are called radiofrequency pulses, whose purpose is to disturb that excess of protons that are at a lower level of energy and that make up the longitudinal magnetization [1, 2, 4, 8].

Do not all wrist managed to disturb the long magnetization Vector alone a Radio frequency wrist with the same frequency of precession (Larmor equation). give it log into in resonance and to interact. Using radio frequency Pulse to the tissues, creates two Effects. The first is to provide energy the protons caused some from to with be arranged in antiparallel, whereby the longitudinal axis decreases Magnetization; the second causes the protons to log into synchronicity And Start process what is generated in phase the with load carriers of some protons are now joining through Direction to the magnetic field, building a new cross Magnetization. In short, the high frequency pulse causes longitudinal magnetization decrease and a new cross magnetizations are formed, which can be measured and delivers Information on magnetic contrast the fabric.

A high frequency pulse that overturns the magnetization generating a new transverse magnetization vector is 90 degrees al initial longitudinal magnetization The vector is called a "90-degree pulse". Others have called it high-frequency pulses according to the angle at which they arise They are possible; however, the most commonly used pulses in the generation of the magnetic resonance sequences are 90 and 180 Level (Number 1 a, b, c)) [1, 9].

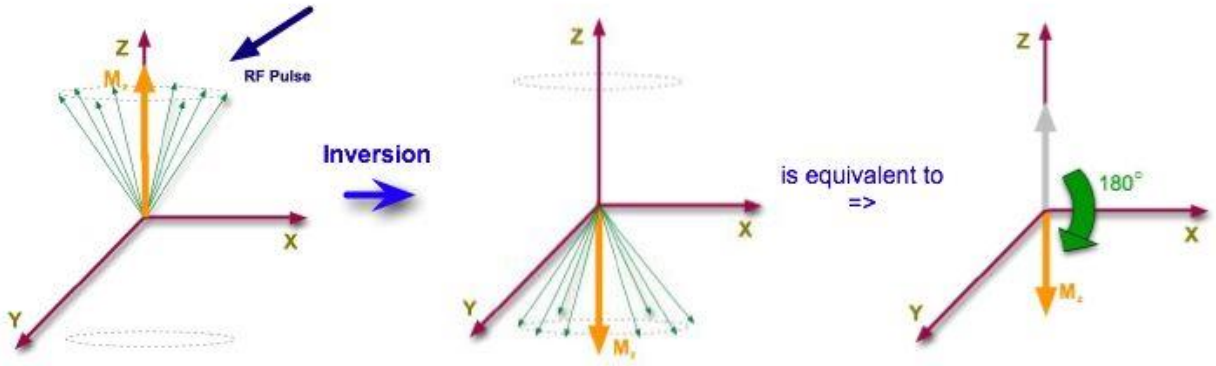

figure 1. Effect from a 90 degrees radio frequency wrist. when to send the radio frequency wrist, some protons to catch power and movement to a higher power also, the sinks the long magnetization (**figure 1a**). That protons to receive in synchronize and start to processes in phase (**figure 1b**). the carriers are added in the through Direction to the magnetic setting up and a through magnetization or total vector is established the represented the total magnetic moment from a tissue (**figure 1c**).

After receiving the cross-Magnetization vector, the next step enables magnetic information Contrast of the fabrics to be obtained consists of the interruption of High frequency pulse with which the Protons return to their lowest energy also and lose consistency the phase. This is how they release energy (till now out of stock out the radio frequency momentum) as an electric current called a magnetic resonance signal or Echo, which is picked up by an antenna quantify moon the transverse magnetization disappears (through Relaxation time or T2) and longitudinal magnetization fully restored (longitudinal relaxation time or T1).

The time spent in between the use of high frequency Pulse and the capture of the magnetic the resonant or echo signal is known as Echo Time (TE), a factor that is too important in the generation of different sequences (Figure 2).

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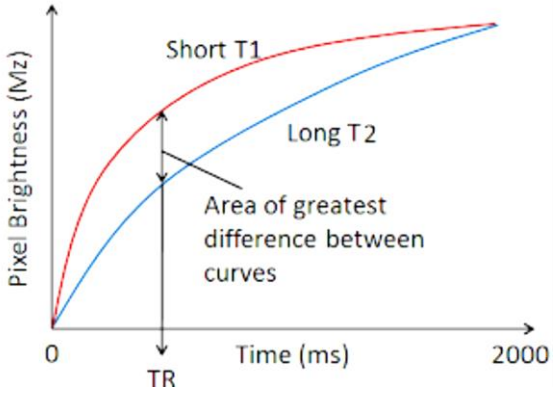

figure 2. break from the radio frequency wrist. That protons Return to the shortest power also, the through magnetization (T2) sinks and the long magnetization (T1) is recovered.

through Relaxation And long relaxation occurs synchronous. That the longitudinal relaxation time is called T1 and it is if 63% of the originally longitudinal has magnetization state recovered. That through Relaxation time is called T2 And it is Self the through magnetization Has Decreased by 37% of its value [1.5]. Relaxation times are tissue property that He can not to be changed and the want supply information on the composition from the examined Tissue. Therefore, varying the technically parameter from sequences, one from the Two Relaxation times Power to be better observed in order to change the Contrast between the tissues [1].

Since the signal used is very small, since he's coming out the small excess from protons those were initially aligned parallel to the magnetic setting up, it is necessary to repeat the measurements many times to the receive an Image that is clinical useful. For this reason, there is more than one radio frequency wrist got to an be Second hand; This is called a wrist Series.

What different types from pulses Power to be Second hand (90 o 180 Level) And the weather intervals in the middle subsequently pulses (Repeat time or TR) can be different, the result is possibility to generate different types from sequences. Hence the choice of a pulse train determines the type signal to receive out a Tissue. This signal is digitized on a grey scale and the appropriate the terminology to describe it qualifies as high, medium, low or zero signal [2].

III. RESONANCE SEQUENCES MAGNETIC

Several technical parameters with which Sequences are scheduled and subject to change to scope a different contrast in the middle the tissue. information about their T1 or his T2. That more frequently manipulated are: repetition Time, echo time and magnetization Deviation Corner [1, 10].

there are Two Basic sequences to out the safe parameter to have state changed to generate the Variety from Sequences currently available. It called the tour echo Series And the gradient echo sequence. The important thing is to comprehend the, however from the from these two is Second hand, pictures the Power to be to receive is equally weighted in T1, in T2 or in proton Density, how explained below [10].

IV. TOUR ECHO SERIES

It is the most common sequence used, also known like an echo from tour. It is characterized through the initial Application of a high frequency of 90 degrees impulse, followed through later at 180 degrees Wrist; after twice the time in the middle these two impulses are either a signal or an echo received from tissue stimulated. Several sequences from pulses from 90 And 180 Level is subsequently applied, all from the product an echo the want module the Radio frequency Wave the offers the molecular information (Figure 3) [2].

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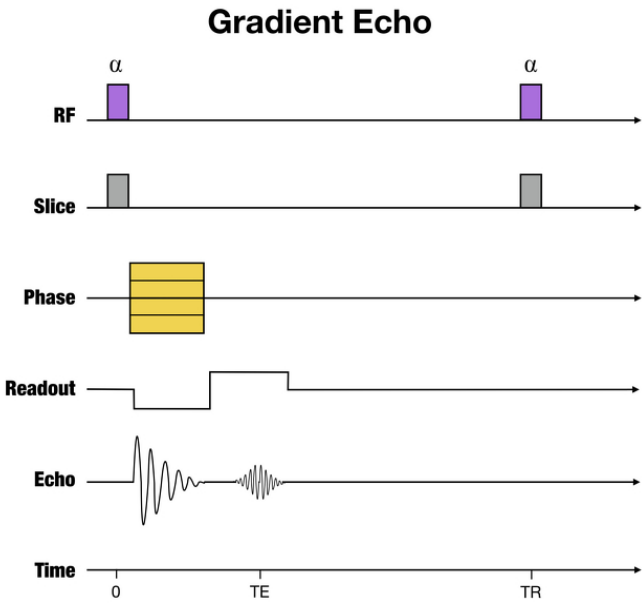

figure 3. Representation from the tour echo Series. An initial 90 Level wrist is product following through a 180 Level Wrist. For twice the time in the middle this Two pulses, the signal or echo Come out the stimulated tissue is to receive.

V. T1 WEIGHTED TOUR ECHO SERIES

weighted images are to receive use short repetition time and echo Time. Through use short echo times, the information is acquired Before through Relaxation; This is Why differences in the long magnetization component in the middle Tissues appear as signal differences Intensity. There from This, structures with times Very short Relaxation times, such how Fat, to appear with tall signal intensity as compared to this with longer Relaxation times, such how Waterfall, like these rich facilities in Waterfall, such how cerebrospinal liquid, the view With Very low signal Intensity. signal Force.

Likewise, the white matter of Brain, being Rich in Fat, is view with greater signal in relation to the Grey It matters, the Has a low signal due to is tall water content. The basic utility of T1-weighted the images in neuroimaging is that the supply Excellent detail from the anatomy And, Self an intravenous contrast medium is used how want to be view after, this images Power Also to demonstrate pathological entity (Count 4a and b) [1].

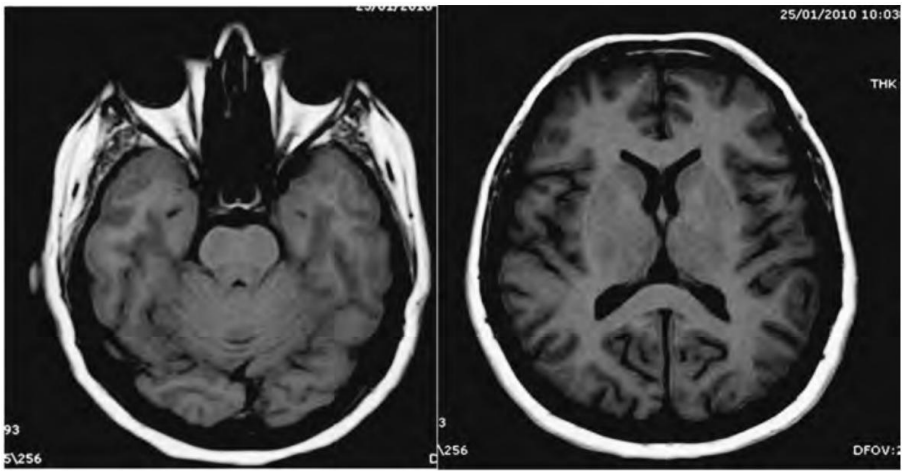

figure 4. T1 weighted tour echo Series. structures With Very short Relaxation times, such how the from the "intraconal" Fat from the Orbit, it observed with a tall signal (**figure 4a**). That White It matters, being Rich in Fat, Also Has a tall Signal. substances with longer Relaxation times, such how Waterfall, to appear Very low Signal; to the Example, the cerebrospinal Fluid and the Grey It matters, the it structures Rich in water (**figure 4b**).

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VI. T2 WEIGHTED TOUR ECHO SERIES

Using a long repeat time, the long Relaxation times in the middle the tissue want to be from the same. Use long echo times, differences in the transverse relaxation time in the middle The fabrics appear as contrast differences in the pictures. So, using long Repeat times and echo times, the Effect is deleted. T1 and T2 weighted images are to receive. This sequence allows for fat be seen as a low intensity signal e liquid how a High intensity Signal, the is Why it is useful in identify pathological injuries are Generally characterized through an increase in water Contents. there is Also an inversion in the signal intensity from the White It matters, the is observed to an have lower signal strength the Grey it matters (Number 5) [1].

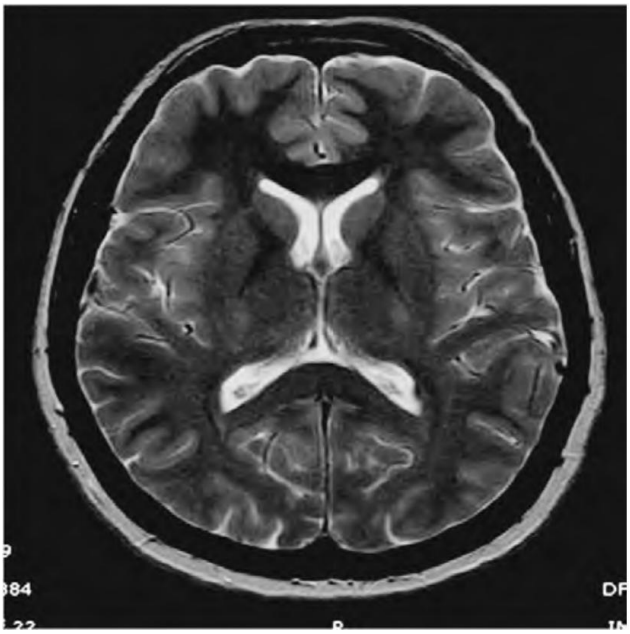

figure 5. T2 weighted tour echo Series. structures with tall water Contents, such how cerebrospinal liquid, the view how high signal; tissue with a tall Fat Contents show low signal and there is inversion from the signal intensity from the White It matters.

VII. PROTON DENSITY GUIDED TOUR ECHO SERIES

If a long repetition time ea. short echo time are combined, the Differences in the long axis magnetization component in the middle the tissue is equivalent to ea. the difference in the density of protons in the nucleus of the hydrogen molecules to the all tissue and is to receive enlarged images in proton Density. liquid structures to produce an intermediate signal and it is bad Distinguish between white matter and grey matter. This episode was previously used to characterize white injuries of the matter; however, it was replaced by other sequences, so it is not one most used in routine neuroimaging protocol (Number 6) [3, 5].

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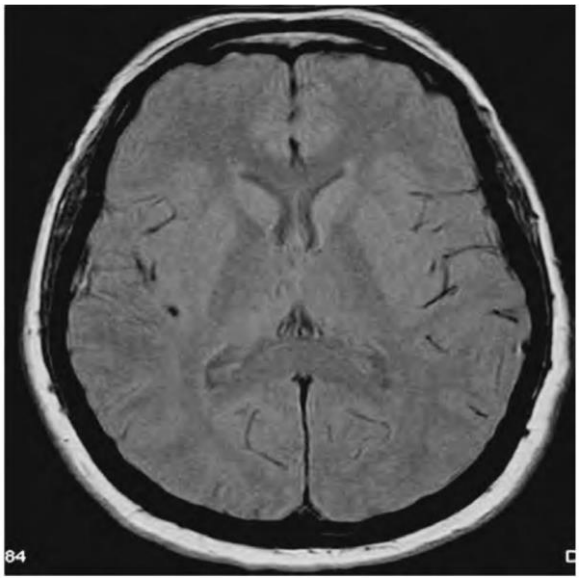

Figure 6. Spin echo sequence with higher proton density. In these images it is the contrast is direct proportional to the Crowd from hydrogen ions the however, tissue Has. we see the cerebrospinal Fluid from intermediate signal and a poor Distinction in the middle White and Grey It matters.

VIII. INVESTMENT SERIES RESTORATION

It is a variant from the tour Series Echo, similar to This, where is it an initial 180 Level wrist is added Before the tour echo Series. This initial 180 Level wrist is known how the inversion wrist e contains a in addition parameter known how inversion time (TI), used to reverse or selectively cancel the signal of some Fabric [1].

If the investment time is short, obtains an image in which the fatty tissue signal is cancelled; This sequence is called STIR (Short TI, inversion Recovery). not usually done routine, but when interested in evaluating structures with high fat content, as the orbit (figure 7) [2].

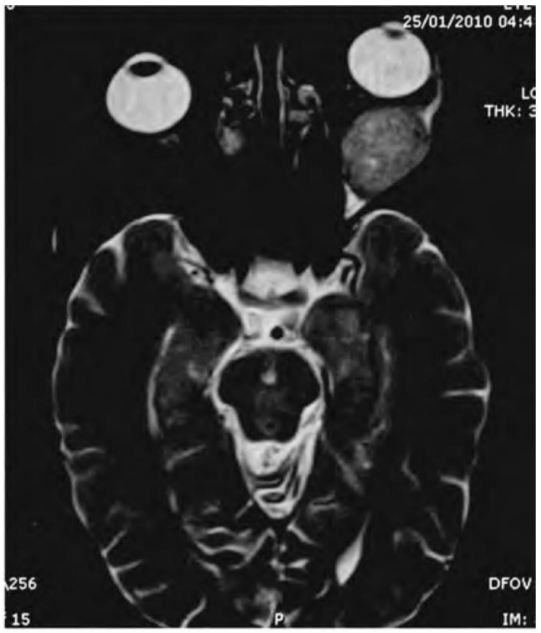

Figure 7. STIR. The signal from the fat is cancelled; it is useful Self it Interested in to analyse structures to surround through a lot of from Fat, how view in This to learn from a They left infraorbital Dimensions.

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Use a long inversion time Instead of this distant or dampens the signal out structures with tall water Contents, such how cerebrospinal Fluid. Through renewal the Series (through use a long inversion Time), an image is to receive Whose, whose prevalent information is On the T2 from the Tissue. This Series, the is in reality a T2 weighted Series, is known how FLAIR (Fluid submissive reversal recovery). It offers an image similar to this the density of the proton weighs one, with dark cerebrospinal liquid, but with poor contrast in the middle White it matters And Grey It matters; However, pathological changes are observed hyper intense with high sensitivity to proton Density. This Series deleted the signal out the cerebrospinal liquid, but do not the signal out pathological injuries the Generally currently an increase in his water Contents or Enema, like this it is useful in his ID And Has replaced the proton Density, Want par from the routine protocol (Count 8th a and b) [1,2].

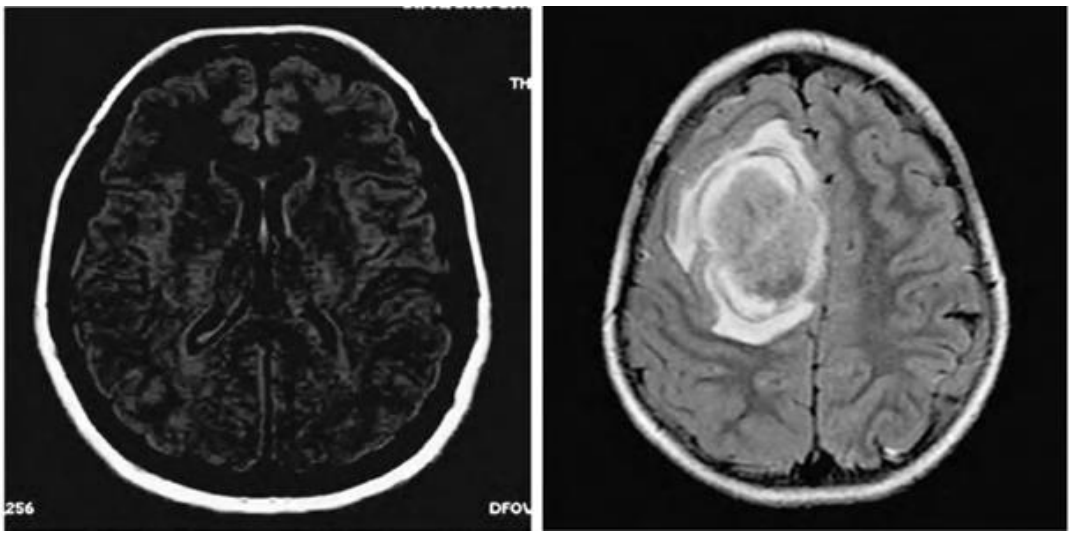

figure 8. FLAIR. It is a T2 weighted Series, in the and signal out the cerebrospinal Fluid is cancelled. That White it matters is observed to cancelled have a minor signal intensity in relation to the Grey it matters (typical from T2 strengthening) And hypointense cerebrospinal Fluid (**figure 8a**). right front parasagittal interaxial wound the busy place and is to surround through Enema, better displayed in FLAIR how a tall intensity signal (**figure 8b**).

IX. ECHO SLOPE SERIES

This is one way to capture the signals or echoes without applies 180 Level pulses after the initial 90 Level Wrist; instead, the polarity of the outside Magnetic field to which the tissue is exposed suspended is gradual turned. This process is known as gradient inversion echo detection. It instead, is a technique that begins with an impulse similar to the one Second hand in the tour echo Series, but from shorter Duration, this causes the alignment of the Magnetic fields of precession Atoms are modified at a lower angle how 90 Level. in the This Series, the Parameters that must be considered Account is the angle from Deviation from magnetization as it is more important how the repetition time and echo time to instead, determine the Guy from information to instead, be to receive. Generally, angles greater than 45 Level supply enlarged information on T1 and small (less than 30 Level) to have Very low T1 One shot. This means that with so little Angle, T2 weighted information no received, but has simply very little Influence of T1, hence the information is T2 * -weighted or magnetic vulnerability, a sequence that is sensitive to heterogeneity of Magnetic field caused by several Factors including haemoglobin degradation products. Here because, is utility is based on the recognition from bleeding And the Assessment from Transformation. haemorrhagic injuries (Number 9) [1, 2].

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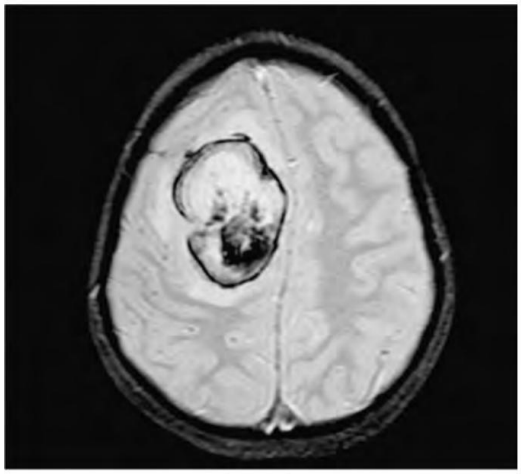

figure 9. T2 * Series (T2 Asterisk) or magnetic Susceptibility. That haemorrhagic transformation in This To the right front wound is observed how a Lost from signal product through haemoglobin degradation Products, the give the Local magnetic setting up lose Homogeneity.

The repetition time and the echo time the parameters in this order are many shorter than those used in spin echo Series; how the Deviation angle is Also the sequence of the gradient echo is smaller much faster than the spin echo sequence, making it ideal to study with contrast medium or with persistent breathing [3].

X. CONTRAST AVERAGE

They are paramagnetic substances that alter local magnetic fields shortening or accelerating the times of relaxation, so its main effect is a reinforcement of the relaxation of the protons, shortening T1 and T2 of the tissues in which they pass. Produce a normal signal increase from the entire brain parenchyma; However, in those sites where the blood-brain barrier has been altered by the presence of an injury, produce an enhancement pathological.

In neuroimaging, the medium of Contrast used is gadolinium and for your app will prefer images T1-weighted, in which they are seen high intensity pathological lesions that are enhanced after its administration (figures 10 a and b) [5].

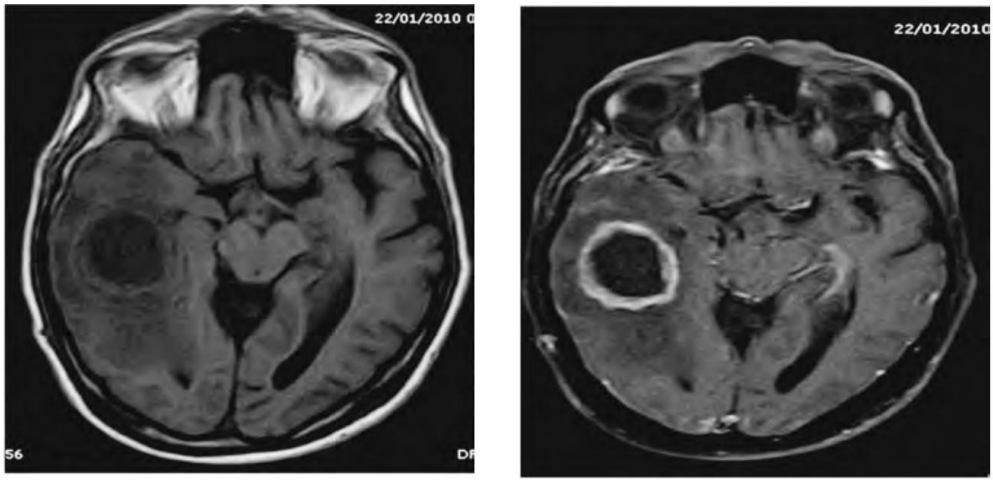

figure 10 contrast Half. With patients diagnosed with colon Cancer, in to the a cystic how wound is observed in the subcortical and deep White it matters from the to the right thunderstorm tore up (figure 10A), the gifts an often capsule the is intensive enlarged after administration from the contrast Half (figure 10b), the allowed the wound to an be marked, to drive the differential diagnosis to cystic metastasis or Brain Abscess.

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XI. CONCLUSION

Interpretation of MRI images of the brain is It is important to understand the methods used Create them as a contrast in the image in particular it depends on how the information it was acquired.
That physically bases from magnetic resonance and is important role in the generation from different sequences. That Features to have state described all Series And its usefulness:
T1: offers Completely anatomical Information.
T2, FLAIR And T1 with contrast Average: is significant to recognize and characterize injuries.
T2 * (T2 Asterisk) or magnetic Susceptibility: It is important to identify the factors that are changing this Homogeneity of the magnetic field, egg bleeding, Calcifications, metals or air.

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