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### Stronger Isn't Always Better: 1.5 Tesla vs 3 Tesla Magnetic Resonance Imaging Scanners

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# Stronger Isn't Always Better: 1.5 Tesla vs 3 Tesla Magnetic Resonance Imaging Scanners

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## Introduction

Magnetic resonance imaging (MRI) is an imaging modality that does not utilize ionizing radiation. MRI provides anatomic and physiologic information by producing cross sectional images to visualize muscles, organs, and soft tissues. MRI screening and safety is a crucial part of the exam due to the magnetic fields utilized. The most common magnetic strength utilized for clinical diagnosis are 1.5 and 3 tesla. Tesla is the unit of magnetic field strength. 1 Tesla is equivalent to 10,000 gauss, whereas the earth's magnetic field strength is 0.5 gauss. The higher the strength of the magnet, the greater the image quality.

(Pierce & Nelson, 2023)

## MRI Safety

- Patients are required to complete a screening form, evaluating patient history
- The patient's history includes previous surgery, metal injuries, implanted devices, contrast allergies and possibility of pregnancy
- The screening form is reviewed with MRI personnel to identify any potential risk with the MRI
- With the increase of data and technology, surgical implants can be scanned if MRI safe
- If implant safety is in question the implant must be cleared by MRI personnel, and the technologists must follow protocols specific to the implant
- Surgical implants such as metal plates and screws can also be scanned if MRI safe
- When metal is introduced to the magnetic field, there is a chance of the metal pulling or heating while in the scanner
- MRI burns to the skin or internal tissues can be a result of the metal heating during the scan

(Lorenza et al., 2017)



(Richards, 2024)

## MRI Zones

- To regulate MRI safety, safety zones have been established to protect patients and personnel
- These zones are set in place to ensure only knowledgeable and certified personnel have access to specific areas of the department
- Zone I: least restricted; open to the public
- Zone II: includes the patient changing rooms and screening rooms
- Zone III: is potentially hazardous energies; only MRI personnel and properly screened patients are permitted
- Zone IV: most restricted area/ greatest safety risk; contains the MRI scanner

(Urone & Hinrichs, 2022)

## MRI Operations

- An MRI scan is created by magnetic fields, coils, which is the looping of wires used to provide a magnetic field from the current flowing through the wires, gradient and radio frequency which is the burst of radio waves to determine the amount of energy given to the nuclei
- MRI begins with the externally applied magnetic field with interactions from nuclei of hydrogen atoms from radio waves
- The nuclei of the hydrogen atom contains a small magnetic field, which when placed in an external magnetic field of the machine, the nuclei either push or align with the new energy
- The bar magnet is composed of two poles, one that attracts and one that repels
- This depends on the spin like the north and south pole in a bar magnet
- Magnetic atoms have both a north and south pole
- The MRI scanner is a device that uses superconducting cylindrical coils for the main magnetic field
- The hydrogen atoms are what produce the medical information
- The location and density of the atoms determines MRI signal in hydrogen images
- The cross-sectional planes or three-dimensional images that the machine creates allows for more than two-dimensional images

(Urone & Hinrichs, 2022)

## Magnetic Strength / Difference

- 3T provides higher field strength and higher signal yield compared to 1.5T
- An increase in signal to noise (SNR) leads to an increase in resolution
- Larmor frequency for 1.5 tesla amounts to 63.9MHz, whereas, at 3 tesla, a doubled Larmor frequency of 127.7 MHz occurs
- Energy deposition for 3 tesla is four times higher than 1.5 tesla if same type of radiofrequency pulses are used, resulting in a raised core body temperature

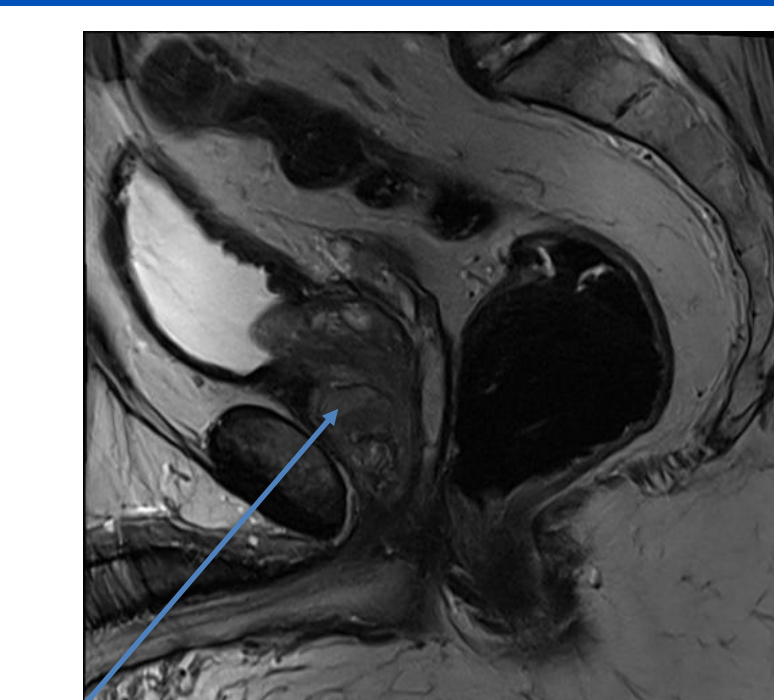
(Pierce & Nelson, 2023)

	1.5 tesla Magnetic Resonance Machine	3 tesla Magnetic Resonance Machine
<b>Image Quality</b>	<ul style="list-style-type: none"> <li>• Less signal to noise ratio (SNR)</li> <li>• Lower resolution</li> <li>• Less image quality</li> <li>• Inability to visualize smaller details</li> </ul>	<ul style="list-style-type: none"> <li>• Greater signal to noise ratio (SNR)</li> <li>• Greater resolution</li> <li>• Greater image quality</li> <li>• Ability to visualize smaller details</li> </ul>
<b>Implant Sensitivity</b>	Uses lower repetition time (TR)	Requires higher repetition time (TR)
<b>Metal Decompression</b>	<ul style="list-style-type: none"> <li>• Less susceptible to metal artifacts</li> <li>• Greater ability to decompress metal artifact</li> </ul>	More susceptible to image artifact
<b>Heat distribution</b>	Less chance of MRI burns	Greater chance of MRI burns
<b>Cost</b>	Less expensive	More expensive
<b>Availability</b>	More available	Less available
<b>Test speed</b>	Slower test speed	Faster test speed

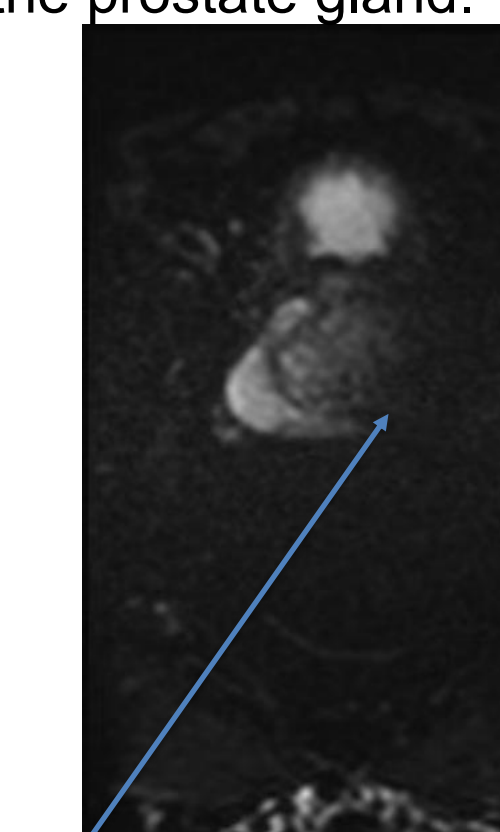
(Richards, 2024)



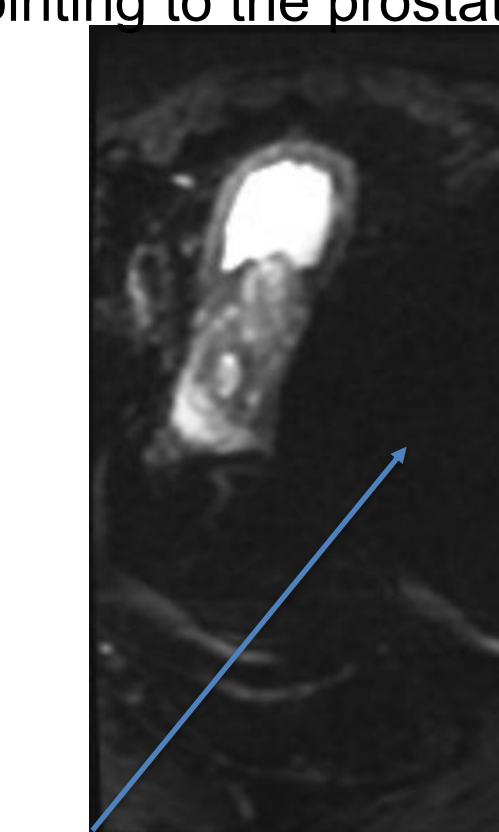
1.5T Sagittal: This is a prostate scanned on the 1.5 tesla scanner. The image quality is grainy and detail is lost. The arrow is pointing to the prostate gland.



3T Sagittal: This is a prostate scanned on the 3 tesla scanner. The image quality is greater and detail is increased. The arrow is pointing to the prostate gland.



1.5T Axial DWI: This is a prostate scanned on the 1.5 tesla scanner. The metal is decompressed and the artifact is less visualized over the area of interest. The arrow is pointing to the better visualization of the prostate.



3T Axial DWI: This is a prostate scanned on the 3-tesla scanner. The metal is not decompressed, and the artifact is visualized over the area of interest. The arrow is pointing to the metal artifact.

(Clinical Affiliate Site, 2026)

## Common Exams

Body Regions	Beneficial Field Strengths
Implants	1.5T
Breast imaging	1.5T
Lung, anatomical & functional	1.5T +
Whole body MRI with consistent quality	1.5T +
Prostate Imaging	3T
Anatomical brain and head	3T +
Functional brain	3T +
Extremity musculoskeletal	3T +
Body trunk	3T +
Cardiac anatomical & functional	3T +
Anatomical abdominal & pelvic, spine	3T +

(Schick et al., 2021)

(Jannat et al., 2025)

## Conclusion

MRI is a non-invasive, nonionizing examination to diagnose patients. With emerging technology, the scan time is quicker, and the images produced are sharper in quality. The magnetic strength creates safety concerns and implant sensitivity that decipher which scanner should be utilized. Although there are newer upcoming scanners, stronger isn't always better.