MAGNETOM Free.Star: Initial Experience in a Tier 3 Indian City

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Why MAGNETOM Free.Star fits

India is now the world's most populous country, home to more than 1.4 billion people. The private healthcare sector is the major healthcare provider [1], and patients usually pay their healthcare expenses directly because health insurance coverage is very limited [2]. Recently, the operating costs of diagnostic centers have increased significantly, partially as a result of rising equipment and maintenance costs, inflation, and higher wage costs. However, patients' financial resources remain largely the same.

On another note, we do not have an appointment system in India. Patients always walk in for exams and prefer to move to another diagnostic center if the waiting time is too long. Infrastructure-related challenges like space and power requirements are also a critical consideration for healthcare providers.

At our diagnostic center, we were handling over 60 cases per day using our 1.5T MAGNETOM ESSENZA system, and we had the potential to handle close to 90 cases per day – this means we were turning away 30 patients in a given day either needing to schedule them to a later time or having them travel to the next available imaging center. To increase our throughput and minimize patient waiting time, we began looking for a second MRI scanner that would be able to perform more exams with good image quality, but with a lower total cost of ownership. This was around the time that Siemens Healthineers was launching its new scanner that requires just 0.7 liters of helium.

I have always had an affinity for new technology, so I was very interested to learn about the innovations behind the new MAGNETOM Free.Star scanner. We were the first center in our region to invest in a MAGNETOM ESSENZA in 2007, and we are always looking to explore new technologies that can deliver on our practical needs. MAGNETOM Free.Star is very practical: Its DryCool technology, which makes it possible for this MRI system to operate on only 0.7 liters of helium, addresses the current challenges of rising helium prices and declining availability, and the scanner also has a very small footprint with no quench pipe. In addition, its simple BioMatrix Select&Go workflow, myExam Autopilot, and contour coils are forward looking technologies that are likely to have a positive impact on daily routines.

> *"I'm also a big admirer of the latest technology. When I heard from the team at Siemens Healthineers that they had designed a new machine with virtually no helium, less space and power requirements, and lower maintenance costs, I was very curious about this product. After learning about the features, I placed an order for not one but two scanners to be installed across my centers. The magnet requires only 24 square meters and it weighs just 3.1 tons. This is relevant, because I have installed this scanner on the first floor."*

Workflow with MAGNETOM Free.Star

MAGNETOM Free.Star allows us to easily handle over 40 cases a day, and we're consistently doing more than 30. Our cases are approximately 60% neuro, 20% body, 18% musculoskeletal, and 2% special studies.

Minimizing patient positioning times and having faster scan times, thanks to the built-in Deep Resolve technology, are important for our MRI exams schedule. Our MAGNETOM Free.Star is equipped with AI-enabled BioMatrix Select&Go, which enables one-touch patient positioning without laser light landmarking. It also has lightweight and conformable contour coils, which are easy to setup and enhance patient experience. We can do brain and spine positioning (about 60% of our routine work) in less than 30 seconds, body positioning in under 40 seconds, and MSK positioning in roughly 40 seconds. Afterwards, myExam Autopilot allows the radiographer to perform multiple tasks, while a single person can handle the scanner.

> *"I am performing about 40 cases with MAGNETOM Free.Star. The overall workflow is seamless and allows me to handle more cases. Now everything is automatic, my team can do automatic positioning, automatic planning, and automatic scanning. This helps us save more time."*

Image quality

The image quality in MRI must be diagnostic: Images must have an adequate signal-to-noise ratio, good in-plane and through-plane resolution, and should not miss any potential pathologies. MAGNETOM Free.Star is equipped with modern technology to make the most of the field strength. This includes Deep Resolve (for denoising and matrix improvement), Simultaneous Multi-Slice (SMS), and Compressed Sensing. These features allow us to produce the good diagnostic images we need. Table 1 lists our protocols for brain, spine, knee, shoulder, and abdomen exams. The following cases demonstrate the benefits of MAGNETOM Free.Star:

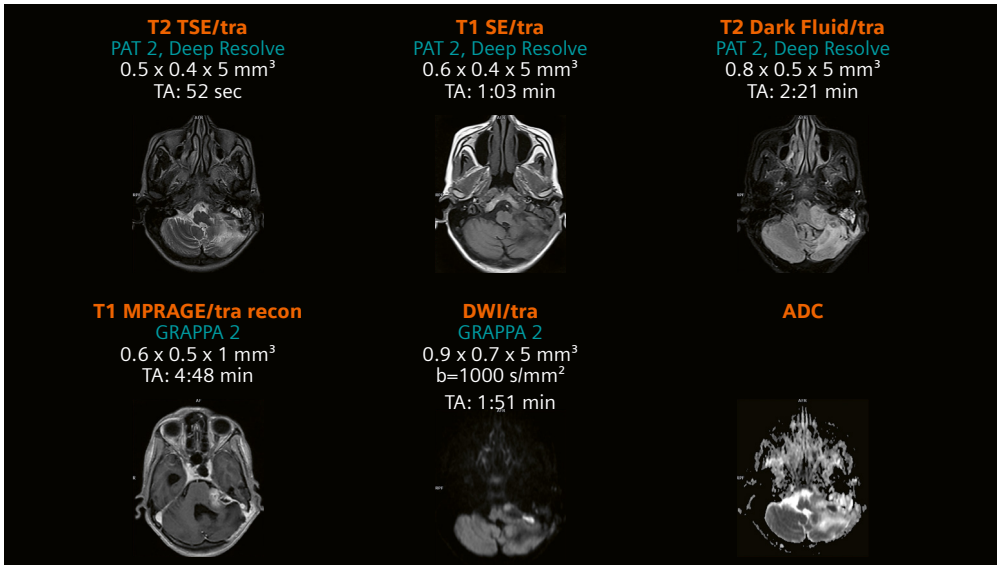
Protocol	Sequences	Prep time	Scan time	Total time
Routine brain	Axial: T2 TSE, DWI, T2-FLAIR, GRE; sagittal: T1 SE	~30 sec	~12 min	~15 min
Contrast brain	Routine brain + 3D MPRAGE	~30 sec	~17 min	~20 min
Brain with 3D-TOF	Routine brain + 3D Time Of Flight	~30 sec	~17 min	~20 min
IAC/Cranial nerves	Routine brain + 3D T2-SPACE+3D TOF/post-contrast T1 (if required)	~30 sec	~16/21 min	~25 min
C-spine with whole-spine screening	Sagittal: T2 (2-station), T1 (cervical), STIR; axial: T2 TSE	~30 sec	~20 min	~22 min
LS-spine with whole-spine screening	Sagittal: T2 (2-station), T1 (cervical), STIR; axial: T2 TSE	~30 sec	~20 min	~22 min
Liver + MRCP	Axial: T2 HASTE/BLADE TSE, DWI, TrueFISP, VIBE Dixon; coronal: 3D MRCP/radial MRCP	~40 sec	~15 min	~17 min
Whole abdomen	2-station coronal TrueFISP/HASTE and VIBE Dixon; axial: TrueFISP/HASTE, DWI, VIBE Dixon	~40 sec	~18 min	~20 min
Male pelvis	Axial: T2, T2 FS, T1 TSE, DWI; sagittal: T2 TSE; coronal: T2 TSE, STIR	~40 sec	~28/40 min (for CE)	~30/42 min
Female pelvis	Axial: T2, T2 FS, T1 TSE; sagittal: T2 TSE; coronal: T2 TSE, STIR, DWI	~40 sec	~28/40 min (for CE)	~30/42 min
Knee	Axial, coronal, sagittal PD FS; coronal T1 TSE; sagittal/coronal T2	~40 sec	~14 min	~16 min
Shoulder	Axial, coronal, sagittal PD FS; coronal T1 TSE; sagittal/coronal T2	~40 sec	~16 min	~18 min
Hip joint	Coronal: STIR, T1, T2; sagittal PD FS; axial: T2/PD FS, T1 TSE	~40 sec	~20 min	~22 min

Table 1: Common protocols at Dolphin Diagnostic

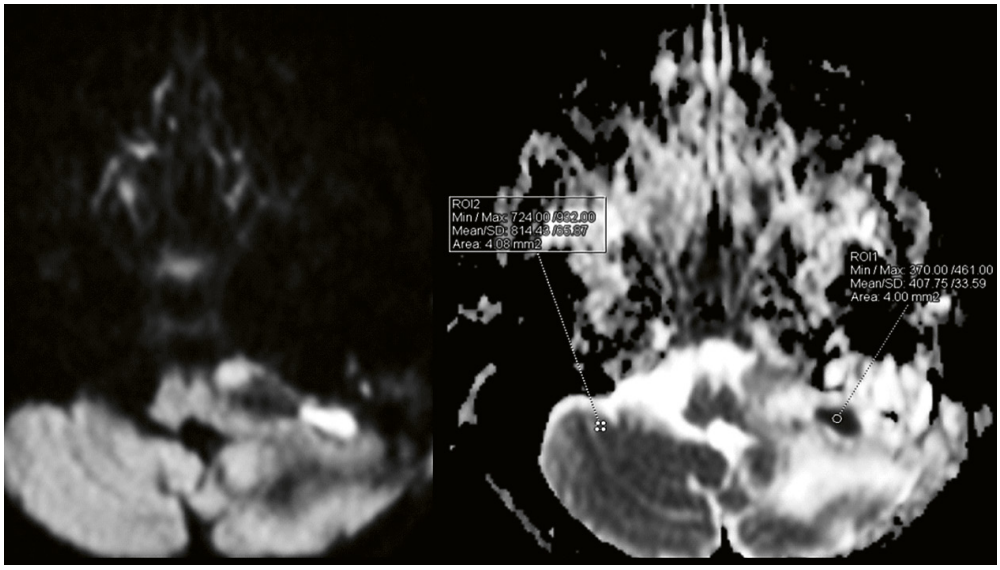
1. Routine brain

Our routine brain examination consists of transverse or sagittal T2-weighted (T2W), T1W, T2FLAIR, GRE, and diffusion-weighted (DWI) sequences. Apart from being quantitative, DWI is one of the most important sequences in pathologies such as stroke, tumors, and infection [3–6]. However, it is known that distortions related to echo-planar imaging that originate from static B_0 field inhomogeneities caused by magnetic susceptibility variations within the object increase with magnetic field strength [7] and can result in missing lesions or cause uncertainty in diagnoses.

One of the most important features of MAGNETOM Free.Star is its excellent DWI capabilities. These are extremely helpful in cases where lesions are in difficult areas of the brain, such as at the skull base or in the temporal lobes. We are also able to do 3D post-contrast imaging in under five minutes using MPRAGE or T1 SPACE sequences.



1 A 48-year-old female patient. Post-operative case showing enhancing lesion (on post-contrast T1 MPRAGE) in the left cerebellum, suggestive of residual tumor. The rim-enhancing lesion shows high restriction on DWI and reduced ADC. The transverse T2-FLAIR shows significant edema in the left cerebellar region.



2 The ADC map shows a significant reduction in ADC values (407×10^{-6} mm²/s compared to contralateral normal with 814×10^{-6} mm²/s) of high diffusion restriction in the cystic component.

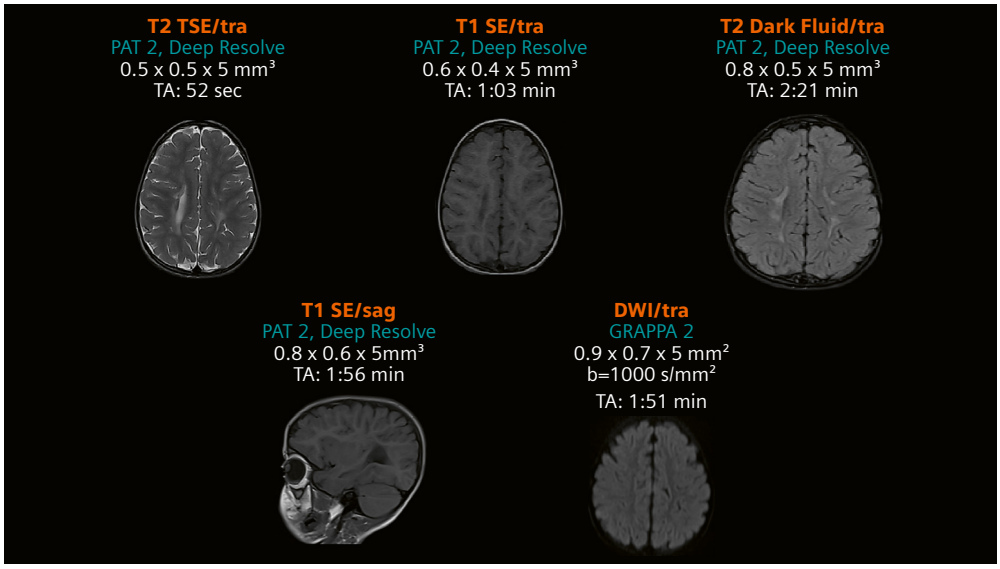
2. Pediatric brain

Pediatric[1] imaging benefits from MAGNETOM Free.Star in a number of ways. Above all, the exams inherently produce very little noise, while also providing excellent T1 tissue contrast. The very short bore length helps reduce patient anxiety and premature exam termination due to claustrophobia.

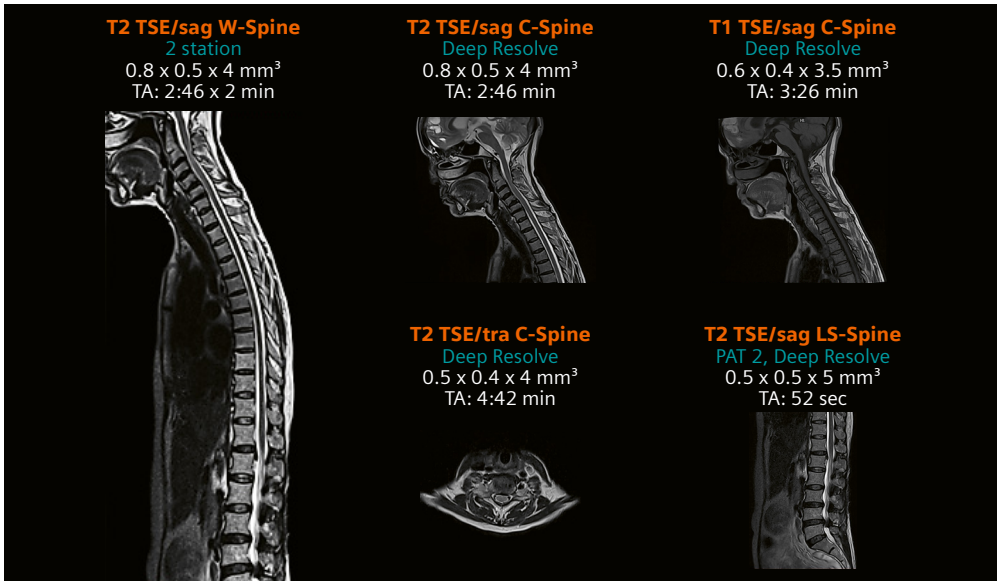
[1] *MR scanning has not been established as safe for imaging fetuses and infants less than two years of age. The responsible physician must evaluate the benefits of the MR examination compared to those of other imaging procedures.*

3. Spine imaging (including single setup whole spine acquisition)

Spine imaging is one of the 'bread-and-butter' imaging applications for us, and the most important requirement for us is the ease of performing this examination. As mentioned earlier, the patient setup for this examination takes less than 30 seconds, in addition, the inline composing and automatic numbering allow our radiographer to perform several tasks at once. In addition, flow artifacts are minimal, and T1W images have better tissue-T1 contrast. Furthermore, we have found that the contrast between the spinal cord and Cerebral Spinal Fluid (CSF) is excellent.



3 A 2-year-old girl. Exam includes transverse plane T2W, T1W, T2-FLAIR, and DWI sequences, showing bilateral symmetric T2/T2-FLAIR hyperintensities in periventricular white matter. The likely cause for the anomaly appears to be periventricular white matter leukomalacia.



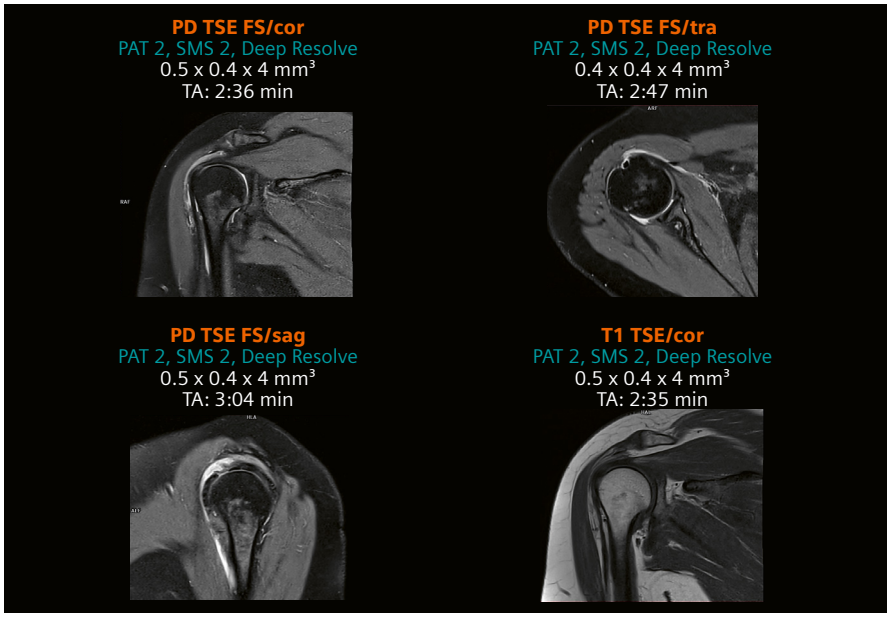
4 A 48-year-old female patient. Exam includes 2-station whole-spine T2W TSE screening, and sagittal T1W and axial T2W sequences for the cervical spine showing cervical spondylotic changes, disc desiccation at multiple levels, and disc bulges with thecal sac indentation at multiple levels in the cervical and lumbar spine.

4. MSK imaging

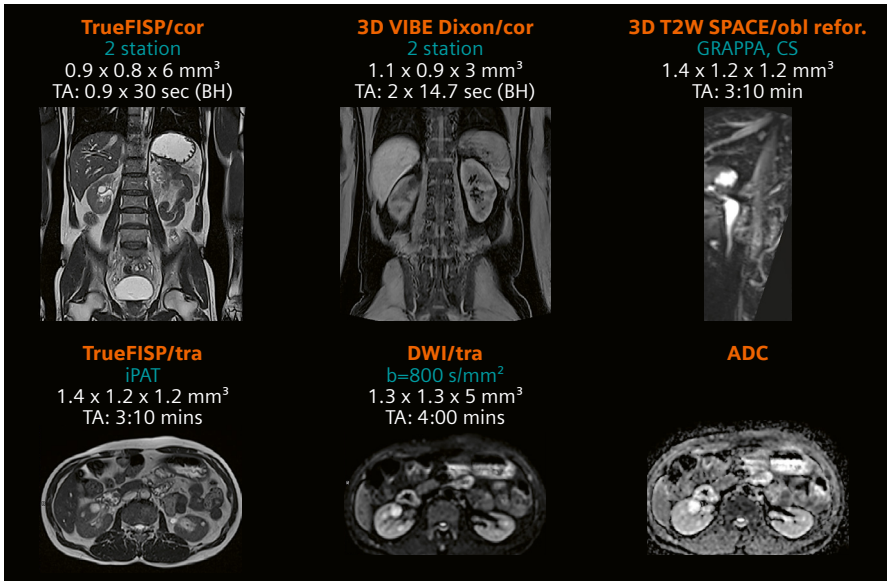
Musculoskeletal MRI requires a very high resolution to enable diagnosis of various clinical conditions. Deep Resolve and SMS help us optimize both image quality and scan time without compromising on either aspect. Another benefit of MAGNETOM Free.Star are the Contour coils, which are light weight coils designed to improve patient comfort and support quick positioning. The dedicated MSK positioning cushions help immobilize the patient and allow us to achieve very good image quality. We are able to do knee and shoulder exams in under 15 minutes, with excellent fat suppression even in off-center anatomies such as the shoulder.

5. Body imaging

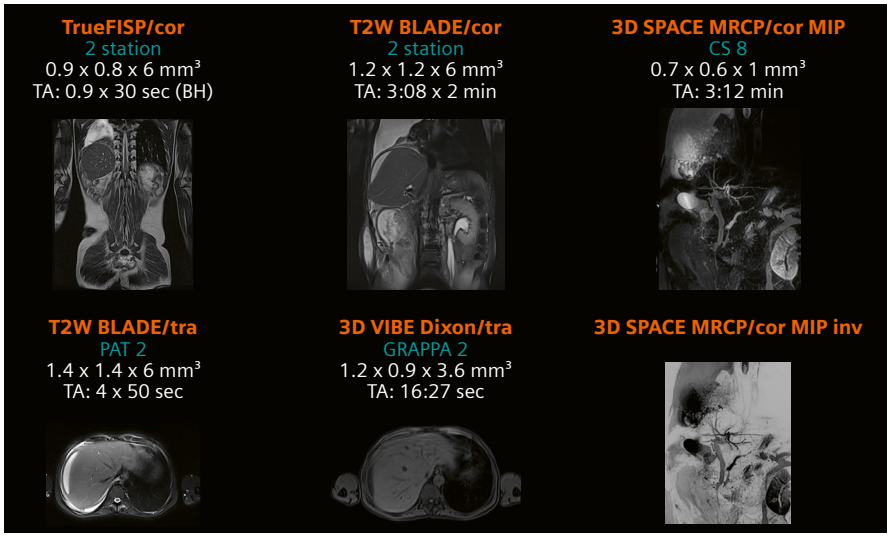
We have found that it is advantageous to perform abdominal MRI on our MAGNETOM Free.Star, as it produces fewer susceptibility, motion, and chemical shift artifacts, and the images are very homogenous without any shading artifacts. The availability of advanced techniques like Compressed Sensing allows faster 3D MRCP acquisition, and we can examine patients with large accumulations of fluid (or ascites) without artifacts. Performing DWI of the abdomen is a major challenge, and even 1.5T scanners can produce shading and distortion artifacts which may obscure lesions in susceptibility-prone areas. With MAGNETOM Free.Star, we get excellent DWI and ADC maps.



5 A 42-year-old female patient. Exam includes transverse, sagittal, and coronal PD-weighted TSE with fat suppression, and a coronal T1W sequence. The images show thin lumen with fluid, and subacromial, subdeltoid, and sub-coracoid bursitis. The supraspinatus tendon shows mild signal intensity changes, suggestive of chronic subtendinosis.



6 A 46-year-old male patient. Exam includes whole-abdomen (2 stations) TrueFISP and 3D VIBE Dixon (T1W) in coronal plane, 3D T2W SPACE in sagittal plane, TrueFISP and DWI in axial plane, and an ADC map. The images show normal structure and signal intensities for the hepatobiliary system, gall bladder, spleen, pancreas, urinary bladder, peritoneum, and prostate. The kidneys show multiple bilateral cystic lesions.



7 A 40-year-old male patient. Exam includes whole-abdomen (2 stations) TrueFISP and T2 BLADE TSE in coronal plane, 3D SPACE MRCP in coronal plane, and T2 BLADE TSE and TrueFISP in axial plane. The images show a large lobulated plural effusion with associated collapse-consolidation of the right lung. The liver shows perifissural atrophy, a loculated collection over the surface of the liver parenchyma. Free fluid is visible in the right external and internal oblique muscle, the paracolic gutter, and the pelvic and peritoneal cavity. The 3D MRCP shows slight dilation in the common hepatic and bile ducts.

> *"We have been operating six 1.5T MRI scanners across our centers. I must say the image quality on this system is excellent. We have been using the system for a wide range of applications, including neonatal[1] scans, fetal MRI, bariatric exams, and for patients with metal implants[2]."*

Conclusion

MAGNETOM Free.Star brings many benefits to radiology departments. It delivers a similar performance to our MAGNETOM ESSENZA 1.5T MRI system, from the perspective of scan time and image quality, and the total cost of ownership is about 30% less. It also allows reliable scanning of patients with implants[2] and is suitable for use in gynecological, gastroenterological, and pulmonological cases, which have not traditionally been the focus for MRI scans. Being able to handle more cases benefits our patients and leads to more revenue and faster break-even. It is important to mention that the system does not have some applications. These include MR spectroscopy, cardiac MRI, and functional MRI. However, in small regions like Visakhapatnam, we mainly require good diffusion, fast workflows, better safety, user-friendly systems, and above all a low total cost of ownership and no challenges when servicing this complex equipment. MAGNETOM Free.Star fulfills all these requirements, and the advantages outweigh the few missing applications.

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[2]The MRI restrictions (if any) of the metal implant must be considered prior to patient undergoing MRI exam. MR imaging of patients with metallic implants brings specific risks. However, certain implants are approved by the governing regulatory bodies to be MR conditionally safe. For such implants, the previously mentioned warning may not be applicable. Please contact the implant manufacturer for the specific conditional information. The conditions for MR safety are the responsibility of the implant manufacturer, not of Siemens Healthineers.