Cardiac Magnetic Resonance Imaging

RTS 3

Introduction to CMR

Cardiac magnetic resonance imaging (CMR) is an emerging medical imaging technique that allows clear visualization of the cardiac tissue, chambers and blood flow. The detailed images and cine clips created with CMR allows clinicians to accurately diagnosis and treat disorders of the heart that can be difficult to quantify with other imaging examinations.[1]

Indications

For accurate and reproducible images of the cardiac chamber volumes and functions, CMR serves as a standard assessment tool with a small amount of limitations. This examination is typically ordered by a cardiologist wanting to better visualize known pathologies or investigate possible abnormalities in the tissue of the heart or blood flow. Left ventricular function, coronary artery disease (CAD) and congenital heart abnormalities are typical indications for magnetic resonance imaging of the heart. CMR allows visualization of these heart conditions with both cine captures and static images that allow optimal visualization of the disease.

Figure 1. Axial slice of interventricular septum with CMR.[2]

Scan Production

Cardiac imaging poses a number of challenges in scan production due to motion and the position the heart lies within the chest cavity. Manipulation of the imaging planes must be done to match the orientation of the heart. To demonstrate proper anatomical views of the heart muscles and chambers multi-oblique images are obtained to demonstrate the heart in profile. To compensate for the motion created with the beating of the heart and respiratory movements within the chest, a technique called gating is used to reduce the artifact. By using electrocardiogram electrodes and a photo-sensor placed on the patient's finger for pulse tracking, the electrical signal of the heart can be used to trigger each pulse sequence. The cardiac cycle is then analyzed and the first radiofrequency (RF) pulse is initiated by the peak of the R wave therefore creating accurate imaging of the heartbeat.

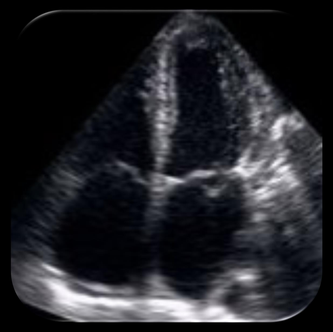

Figure 3. Ultrasound demonstrating the chambers of the heart.[4]

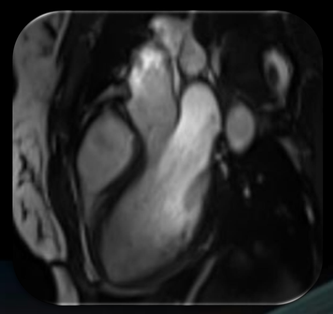

Figure 4. Sagittal image demonstrating the filling of three chambers.[5]

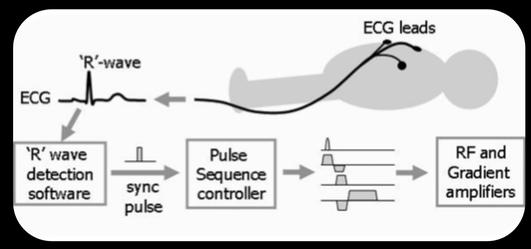

Figure 2. Demonstration of ECG leads inducing MRI sequence.[3]

Diagnostic Value

Until recently, echocardiography, coronary computed tomography angiography and cardiac catheterization were the only options available for imaging the heart. A few years ago, cardiovascular magnetic resonance imaging was developed as an application for MRI scanners to accurately image the beating heart. This tool was developed in conjunction with the principals of electrocardiogram gating to in order to create clear images of the heart during the cardiac cycle. CMR provides detailed images without the use of high levels of ionizing radiation, iodinated contrast media and invasive surgical procedures. The multiplanar imaging available with CMR also helps bridge the gap of echocardiography and angiography in regards to extracardiac vasculature.

Conclusion

CMR can be used to analyze cardiac anatomy, determine cardiac disorders, assess tissue degeneration and visualize blood flow issues without the use of ionizing radiation. The extensive detail produced with this imaging technique can be extremely valuable to cardiologists and clinicians. Although other imaging techniques are considered the dominant source for imaging, cardiac MRI serves as an accurate and reliable way to diagnosis cardiac abnormalities.

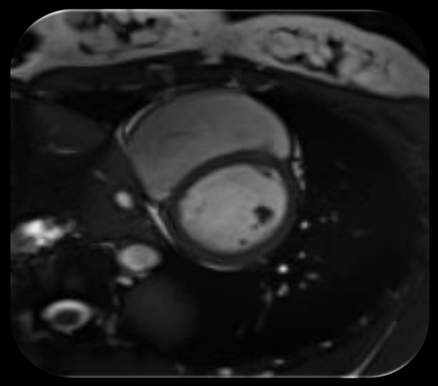

Figure 5. Axial slice demonstrating papillary muscles of the heart.[6]

References

1.Magnetic Resonance Imaging (MRI) of the Heart. Magnetic Resonance Imaging (MRI) of the Heart | Johns Hopkins Medicine Health Library. https://www.hopkinsmedicine.org/healthlibrary/test_procedures/cardiovascular/magnetic_resonance_imaging_mri_of_the_heart_92,P07977. Accessed October 30, 2017.

2. Facility Image

3. Ridgway JP. Cardiovascular magnetic resonance imaging physics for clinicians. BioMed Central. http://www.biomedcentral.com/.

4. Echocardiogram. Heart Failure Matters. http://www.heartfailurematters.org/en_GB/Understanding-heart-failure/Echocardiogram.

5. Facility Image

6. Facility Image