

Guidelines for the Management of Patients with Coronary Artery Stents Referred for MRI Examinations*

Frank G. Shellock, Ph.D., FACR, FISMRM, FACC

**Adjunct Clinical Professor of Radiology and Medicine
Keck School of Medicine, University of Southern California**

**Director of MRI Safety
USC Stevens Neuroimaging and Informatics Institute**

**University of Southern California
www.MRIsafety.com**

In the clinical magnetic resonance imaging (MRI) setting, there is often misunderstanding associated with the management of patients with coronary artery stents, including confusion regarding stents labeled “MRI Safe/MRI Compatible” (i.e., due to labeling applied prior to the change in terminology, 2005) or “MR Conditional”, the timing of performing MRI following stent placement, and regarding what MRI limitations may exist (e.g., those related to the acceptable static magnetic field strength, maximum spatial gradient magnetic field, whole body averaged specific absorption rate or SAR, and other conditions)(1-3, 24). This may result in restricted access to MRI for certain patients, particularly those with coronary artery stents for which there is unknown labeling information.

Notably, the previous belief that it may be necessary to wait six weeks or longer after implantation of certain coronary artery stents to allow for endothelialization or other mechanism to prevent migration has been refuted because there are no known coronary artery stents made from ferromagnetic metallic materials (4-24).

MRI labeling information exists for numerous coronary artery stents. By following the pertinent MRI labeling information (i.e., presented in the *Instructions for Use*, Patient Identification Card, etc.), patients with coronary artery stents have safely undergone MRI examinations, including those performed using MR systems operating at 3-Tesla (3-24). Importantly, there has never been an adverse event reported in association with performing MRI in patients with these implants.

Unfortunately, the standard policy that MRI labeling information is required before allowing the use of MRI in patients with coronary artery stents limits access to this important diagnostic imaging modality for those patients for which labeling is unavailable. However, in consideration of the relevant peer-reviewed literature and other related documents (3-24), it is acceptable and safe to perform MRI examinations in patients with coronary artery stents by following specific guidelines developed by taking into consideration possible safety concerns (i.e., magnetic field interactions and MRI-related heating) for these implants.

By adhering to these MRI conditions, patients with coronary artery stents can benefit from the diagnostic imaging information provided by this important noninvasive imaging modality.

Guidelines. A patient with a with coronary artery stent (including a drug-eluting, non-drug eluting or bare metal version), including situations where there are two or more stents or two or more overlapping stents, may undergo MRI using the following guidelines:

- 3-Tesla or less
- No restriction on the direction of the static magnetic field
- No restriction on the value of the spatial gradient magnetic field
- Whole body averaged specific absorption rate (SAR) of 2-W/kg (i.e., operating in the Normal Operating Mode for the MR system)
- Maximum imaging time, 15 minutes per pulse sequence (multiple pulse sequences per patient are allowed)

***Important Note:** The “*Guidelines for the Management of Patients with Coronary Artery Stents Referred for MRI Examinations*” should only be implemented for use after the careful review by the supervising radiologist or other physician responsible for the MRI facility and with the adoption of the information as a written policy.

Important Note: This information does not apply to other stents such as peripheral vascular stents, abdominal aortic aneurysm (AAA) stent grafts, biliary stents, ureteral stents, or stents used for other applications (e.g., tracheobronchial stents, esophageal stents, etc.).

Important Note: Any deviation from the above MRI conditions requires prior approval by the Radiologist or supervising physician.

Important Note: These guidelines must be reviewed on an annual basis to confirm that no new coronary artery stent has become available that substantially deviates from the above MRI conditions or that is labeled, MR Unsafe.

References

(1) Shellock FG, Crues JV. MR procedures: Biologic effects, safety, and patient care. *Radiology* 2004;232:635-652.

(2) Shellock FG, Woods TO, Crues JV. MRI labeling information for implants and devices: Explanation of terminology. *Radiology* 2009;253:26-30.

(3) Shellock FG. Reference Manual for Magnetic Resonance Safety, Implants, and Devices: 2020 Edition. Biomedical Research Publishing Group, Los Angeles, CA, 2020.

- (4) Levine GN, et al. Safety of magnetic resonance imaging in patients with cardiovascular devices: An American Heart Association scientific statement from the Committee on Diagnostic and Interventional Cardiac Catheterization. *Circulation* 2007;116:2878-2891.
- (5) Ahmed S, Shellock FG. Magnetic resonance imaging safety: Implications for cardiovascular patients. *Journal of Cardiovascular Magnetic Resonance* 2001;3:171-181.
- (6) Curtis JW, Lesniak DC, Wible JH, Woodard PK. Cardiac magnetic resonance imaging safety following percutaneous coronary intervention. *Int J Cardiovasc Imaging*.2013;29:1485-90.
- (7) Gerber TC, et al. Clinical safety of magnetic resonance imaging early after coronary artery stent placement. *J Am Coll Cardiol* 2003;42:1295-8.
- (8) Hug J, et al. Coronary arterial stents: Safety and artifacts during MR imaging. *Radiology* 2000;216:781-787.
- (9) Jehl J, et al. Clinical safety of cardiac magnetic resonance imaging at 3 T early after stent placement for acute myocardial infarction. *Eur Radiol* 2009;19:2913-8.
- (10) Kaya MG, et al. Long-term clinical effects of magnetic resonance imaging in patients with coronary artery stent implantation. *Coron Artery Dis* 2009;20:138-42.
- (11) Karamitsos TD, Karvounis H. Magnetic resonance imaging is a safe technique in patients with prosthetic heart valves and coronary stents. *Hellenic J Cardiol* 2019;60:38-39.
- (12) Patel MR, et al. Acute myocardial infarction: Safety of cardiac MR imaging after percutaneous revascularization with stents. *Radiology* 2006;240:674-680.
- (13) Porto I, et al. Safety of magnetic resonance imaging one to three days after bare metal and drug-eluting stent implantation. *Am J Cardiol* 2005;96:366-8.
- (14) Schenk CD, Gebker R, Berger A, et al. Review of safety reports of cardiac MR-imaging in patients with recently implanted coronary artery stents at various field strengths. *Expert Rev Med Devices* 2021;18:83-90.
- (15) Shellock FG. MR safety at 3-Tesla: Bare metal and drug eluting coronary artery stents. *Signals* No. 53, Issue 2, pp. 26-27, 2005.
- (16) Shellock FG. Biomedical implants and devices: Assessment of magnetic field interactions with a 3.0-Tesla MR system. *J Magn Reson Imaging* 2002;16:721-732.
- (17) Shellock FG, Morisoli S, Kanal E. MR procedures and biomedical implants, materials, and devices: 1993 update. *Radiology* 1993;189:587-599.
- (18) Shellock FG, Shellock VJ. Stents: Evaluation of MRI safety. *Am J Roentgenol* 1999;173:543-546.

(19) Sommer T, et al. High field MR imaging: Magnetic field interactions of aneurysm clips, coronary artery stents and iliac artery stents with a 3.0 Tesla MR system. *Rofo Fortschr Geb Rontgenstr Neuen Bildgeb Verfahr* 2004;176:731-8.

(20) Spuentrup E, et al. Magnetic resonance-guided coronary artery stent placement in a swine model. *Circulation* 2002;105:874-879.

(21) Syed MA, et al. Long-term safety of cardiac magnetic resonance imaging performed in the first few days after bare-metal stent implantation. *J Magn Reson Imaging*. 2006;24:1056-61.

(22) Tejedor-Viñuela P, et al. Safety of early cardiac magnetic resonance imaging in acute myocardial infarction patients with stents. *Rev Esp Cardiol* 2006;59:1261-7.

(23) Wang Y, et al. Magnetic resonance compatibility research for coronary metal stents. *Zhongguo Yi Liao Qi Xie Za Zhi*. 2015;39:61-3.

(24) www.mrisafety.com

02/24