

Guidelines for the Management of Patients with Heart Valve Prostheses and Annuloplasty Rings 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, it is often necessary to manage patients with heart valve prostheses [including *transcatheter aortic valve* replacements (TAVR), *transcatheter aortic valve* implantation (TAVI) devices, percutaneous aortic valve replacement (PAVR) implants, *transcatheter heart valves* (THV), as well as other similar heart valve implants used in association with minimally invasive procedures] and annuloplasty rings (1-21).

MRI labeling information exists for numerous heart valve prostheses and annuloplasty rings. By following the MRI labeling information (i.e., presented in the *Instructions for Use*, Patient Identification Card, etc.), patients with heart valve prostheses and annuloplasty rings have, have safely undergone MRI examinations, including those performed using MR systems operating up to 3-Tesla (5, 16, 21). Notably, 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 heart valve prostheses and annuloplasty rings limits access to this important diagnostic imaging modality for those patients for which labeling information is unavailable. However, in consideration of the relevant peer-reviewed literature and other related documents (1-21), it is acceptable and safe to perform MRI examinations in patients with heart valve prostheses and annuloplasty rings 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 conservative MRI conditions, patients with heart valves and annuloplasty rings can benefit from the diagnostic imaging information provided by this important noninvasive imaging modality.

Guidelines. A patient with a heart valve prosthesis or an annuloplasty ring 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 Heart Valve Prostheses and Annuloplasty Rings 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: Any deviation from the above MRI conditions requires prior approval by a supervising physician.

Important Note: These guidelines must be reviewed on an annual basis to confirm that no heart valve prosthesis or annuloplasty ring has become available that substantially deviates from the above MRI conditions or that is labeled, MR Unsafe.

References

- (1) Ahmed S, Shellock FG. Magnetic resonance imaging safety: Implications for cardiovascular patients. *Journal of Cardiovascular Magnetic Resonance* 2001;3:171-181.
- (2) Edwards MB, Taylor KM, Shellock FG. Prosthetic heart valves: Evaluation of magnetic field interactions, heating, and artifacts at 1.5-Tesla. *J Magn Reson Imag* 2000;12:363-369.
- (3) Frank H, Buxbaum P, Huber L, et al. *In vitro* behavior of mechanical heart valves in 1.5-T superconducting magnet. *Eur J Radiol* 1992;2:555-558.
- (4) Hassler M, et al. Effects of magnetic fields used in MRI on 15 prosthetic heart valves. *J Radiol* 1986;67:661-666.
- (5) 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.
- (6) 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.
- (7) Maragiannis D, et al. Functional assessment of bioprosthetic aortic valves by CMR. *JACC Cardiovasc Imaging* 2016;9:785-93.
- (8) Myers PO, et al. Safety of magnetic resonance imaging in cardiac surgery patients: Annuloplasty rings, septal occluders, and transcatheter valves. *Ann Thorac Surg* 2012;93:1019.

- (9) Pruefer D, et al. *In vitro* investigation of prosthetic heart valves in magnetic resonance imaging: Evaluation of potential hazards. *J Heart Valve Disease* 2001;10:410-414.
- (10) Randall PA, et al. Magnetic resonance imaging of prosthetic cardiac valves *in vitro* and *in vivo*. *Am J Cardiol* 1988;62:973-976.
- (11) Saeedi M, Thomas A, Shellock FG. Evaluation of MRI issues at 3-Tesla for a transcatheter aortic valve replacement (TAVR) bioprosthesis. *Magnetic Resonance Imaging* 2015;33:497-501.
- (12) Shellock FG. Biomedical implants and devices: Assessment of magnetic field interactions with a 3.0-Tesla MR system. *J Magn Reson Imag* 2002;16:721-732.
- (13) Shellock FG. Prosthetic heart valves and annuloplasty rings: Assessment of magnetic field interactions, heating, and artifacts at 1.5-Tesla. *Journal of Cardiovascular Magnetic Resonance* 2001;3:159-169.
- (14) Shellock FG, Morisoli SM. Ex vivo evaluation of ferromagnetism, heating, and artifacts for heart valve prostheses exposed to a 1.5-Tesla MR system. *J Magn Reson Imaging* 1994;4:756-758.
- (15) Shellock FG, Shellock VJ. MRI Safety of cardiovascular implants: Evaluation of ferromagnetism, heating, and artifacts. *Radiology* 2000;214:P19H.
- (16) Shellock FG. Reference Manual for Magnetic Resonance Safety, Implants, and Devices: 2020 Edition. Biomedical Research Publishing Group, Los Angeles, CA, 2020.
- (17) Shellock FG. Biomedical implants and devices: Assessment of magnetic field interactions with a 3.0-Tesla MR system. *J Magn Reson Imag* 2002;16:721-732.
- (18) Soulen RL. Magnetic resonance imaging of prosthetic heart valves [Letter]. *Radiology* 1986;158:279.
- (19) Soulen RL, Budinger TF, Higgins CB. Magnetic resonance imaging of prosthetic heart valves. *Radiology* 1985;154:705-707.
- (20) Shellock FG, Crues JV. MR procedures: Biologic effects, safety, and patient care. *Radiology* 2004;232:635-652.
- (21) www.mrisafety.com

02/24