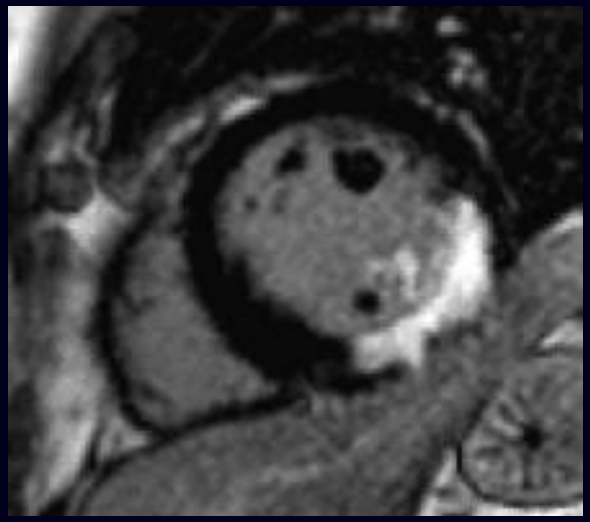
Clínica Universidad de Navarra

CRM en la cardiopatía isquémica:
Extensión y tamaño IAM y viabilidad



Gorka Bastarrika
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Servicio de Radiología
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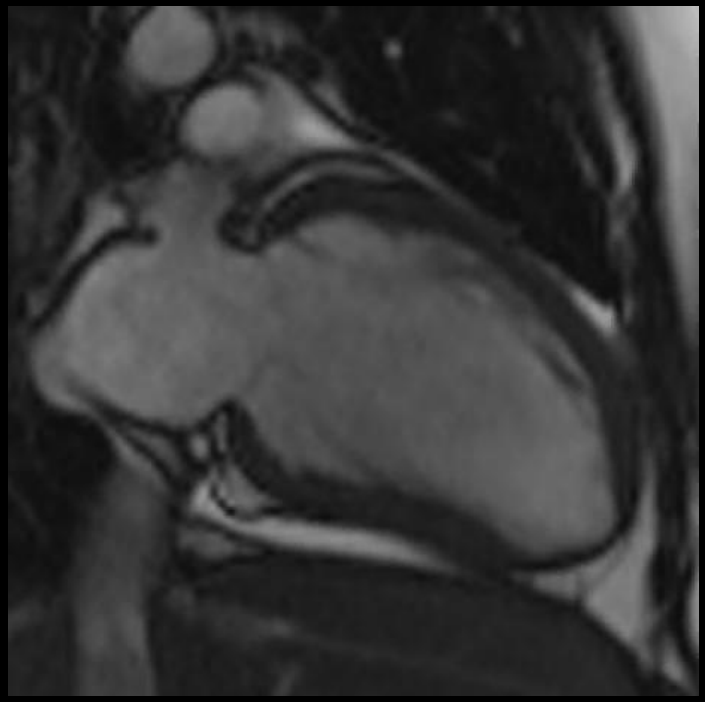
bastarrika@unav.es

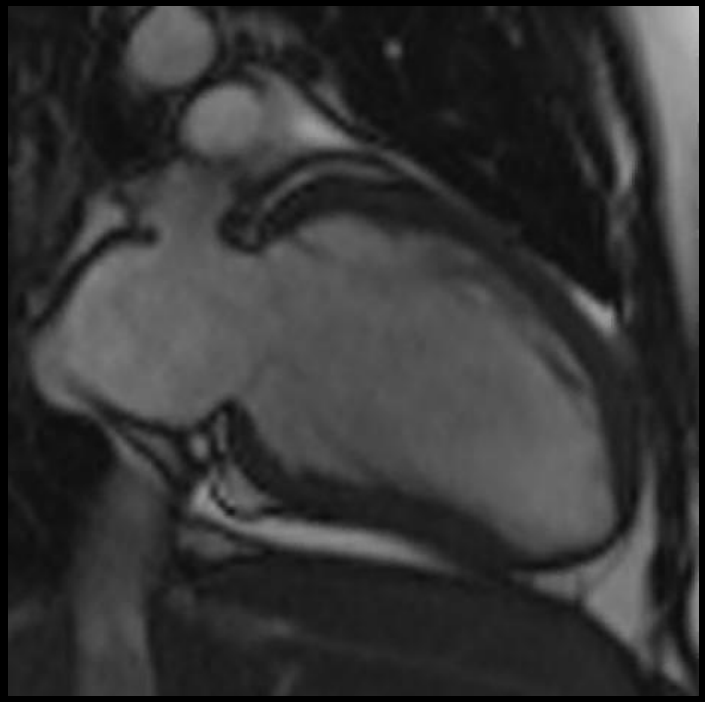
CRM en CI: Extensión y tamaño IAM y viabilidad

- Conceptos
- Protocolo de estudio
  - Infarto agudo
  - Infarto crónico
- Indicaciones CRM
- TCMC en cardiopatía isquémica



CRM en CI: Extensión y tamaño IAM y viabilidad

- Conceptos



- Protocolo de estudio
  - Infarto agudo
  - Infarto crónico
- Indicaciones CRM
- TCMC en cardiopatía isquémica

Conceptos

- Miocardio viable:
  - Miocardio con miocitos vivos
  - Miocardio que recuperará la función tras ser revascularizado
- Miocardio no viable:
  - Miocardio con miocitos necróticos
  - Sustitución de miocitos por fibrosis o cicatriz

- Existe viabilidad miocárdica si la función contráctil mejora tras la revascularización pero no necesariamente es no viable el miocardio que no mejora su función tras el procedimiento

Fieno DS. J Am Coll Cardiol 2000;36:1985–1991
Kim RJ. N Engl J Med. 2000;343(20):1445-53
Dakik HA. Circulation 1997; 96:2892–2898

Introducción

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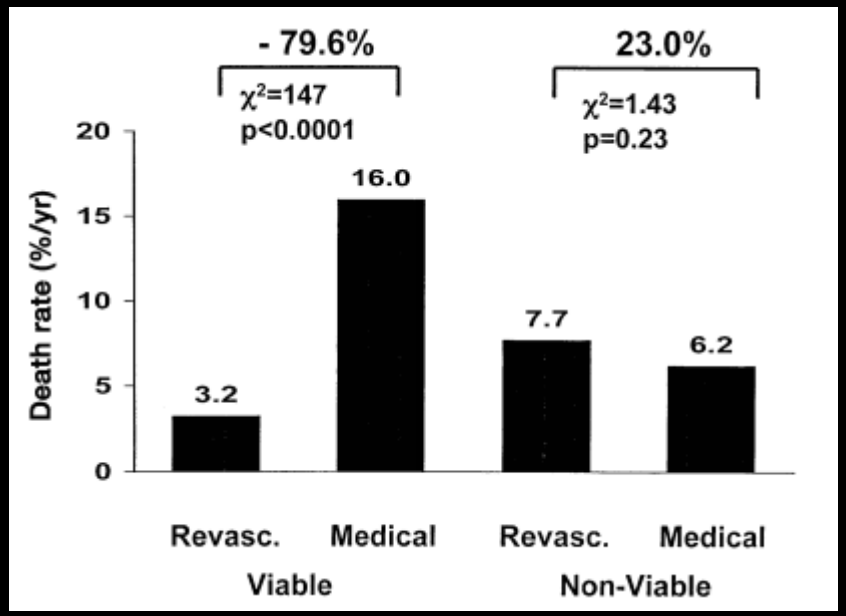
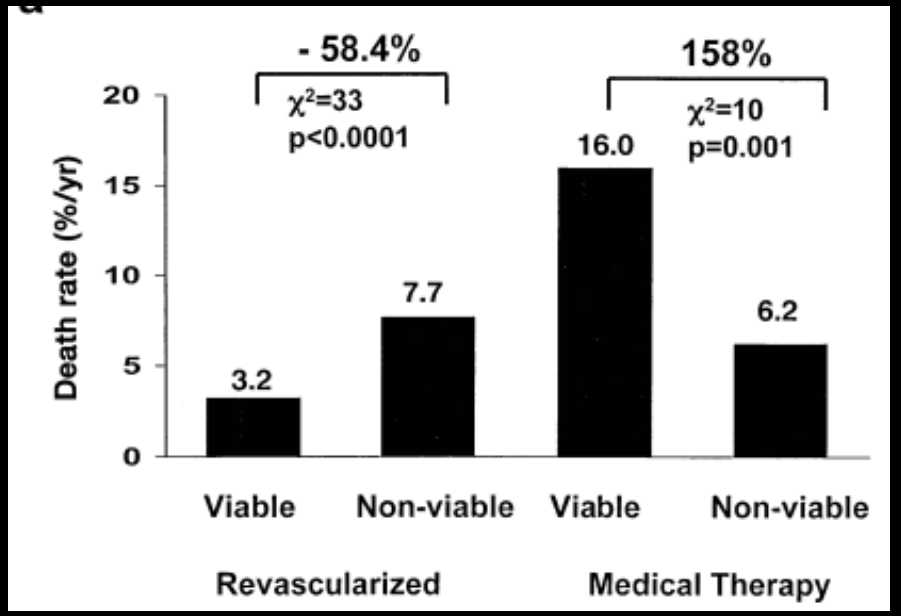
Coronary Revascularization

Myocardial Viability Testing and Impact of Revascularization on Prognosis in Patients With Coronary Artery Disease and Left Ventricular Dysfunction: A Meta-Analysis

Kevin C. Allman, MB, BS, FRACP, FACC,* Leslee J. Shaw, PHD,† Rory Hachamovitch, MD, FACC,† James E. Udelson, MD, FACC‡

Concord, Australia; Atlanta, Georgia; and Boston, Massachusetts





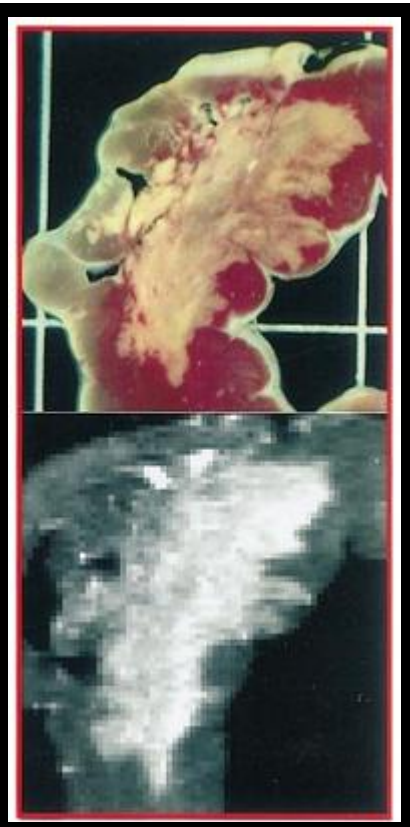
Allman KC. J Am Coll Cardiol. 2002;39(7):1151-8.

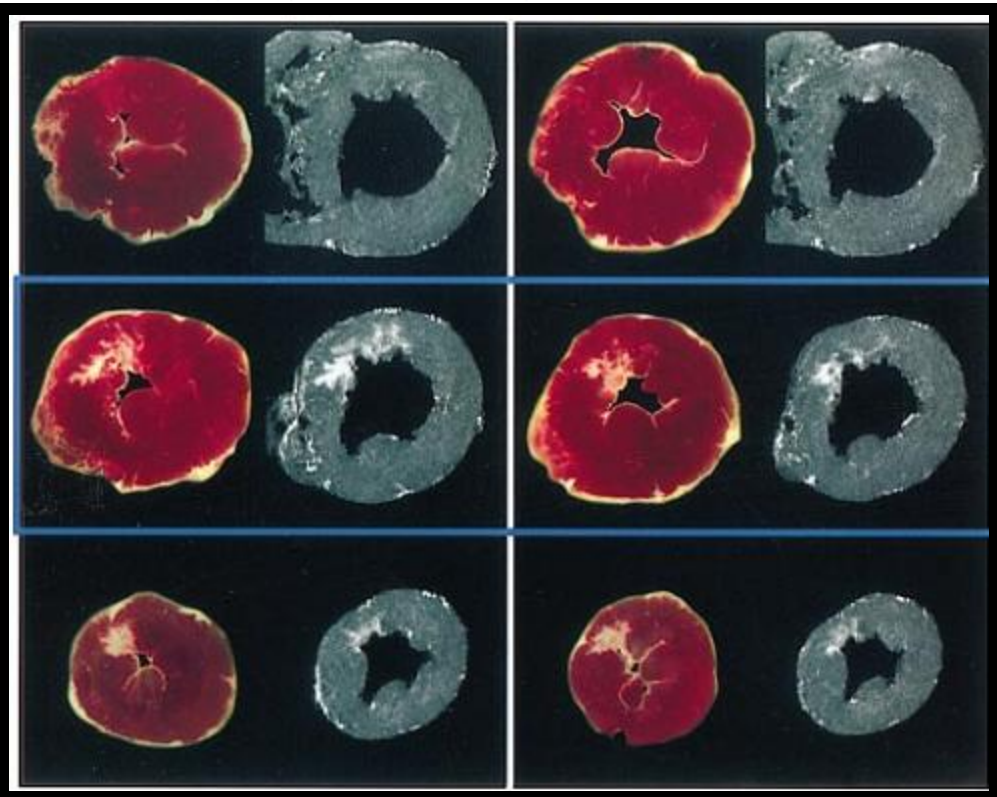
Conceptos

Basic Science Reports

Relationship of MRI Delayed Contrast Enhancement to Irreversible Injury, Infarct Age, and Contractile Function

Raymond J. Kim, MD; David S. Fieno, BS; Todd B. Parrish, PhD; Kathleen Harris, BS; Enn-Ling Chen, PhD; Orlando Simonetti, PhD; Jeffrey Bundy, PhD; J. Paul Finn, MD; Francis J. Klocke, MD; Robert M. Judd, PhD





Kim RJ. Circulation. 1999;100(19):1992-2002.

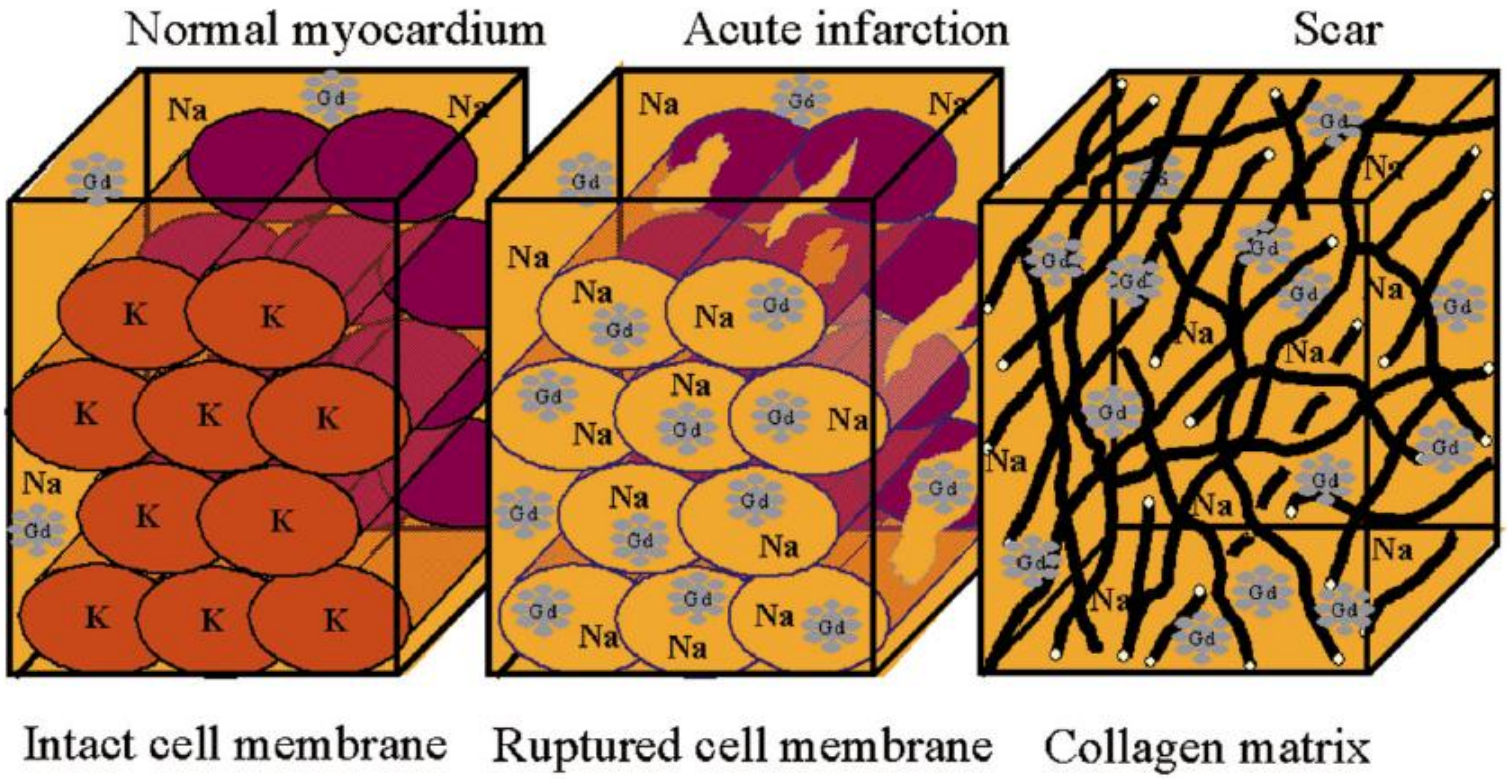
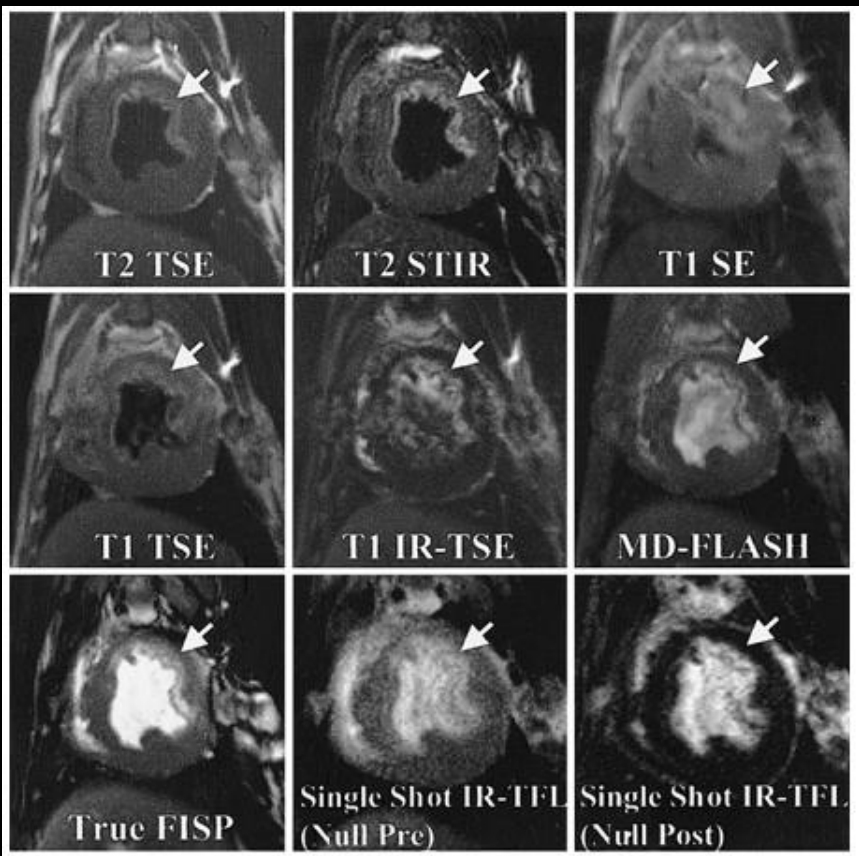


Figure 8. Potential mechanisms of hyperenhancement in acute and chronic MI. See text for details. (Reprinted with permission from Cardiovascular MRI and MRA. Charles B. Higgins, editor. Lippincott Williams & Wilkins, 2002.)



a.

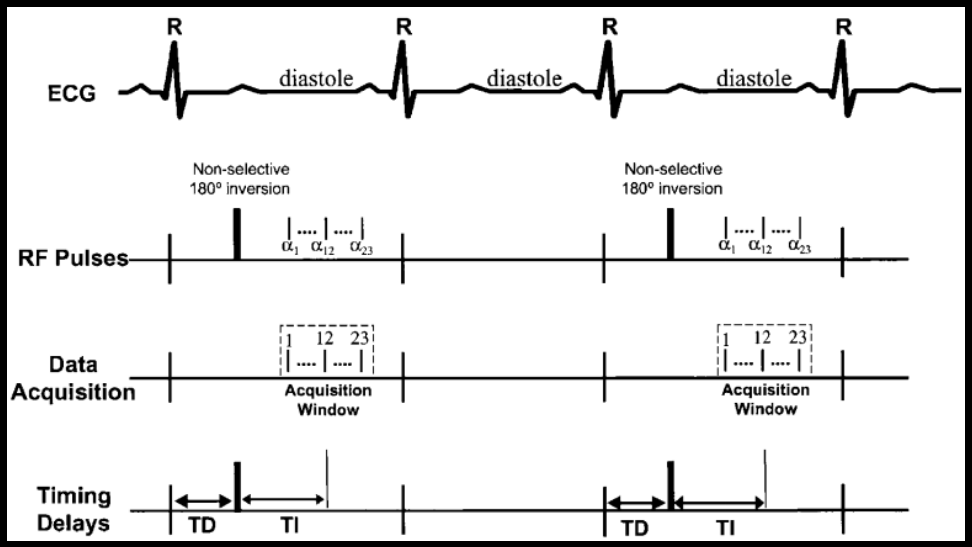
b.

Figure 3. Short-axis images obtained with all the MR techniques applied in one dog. The repetition times, echo times, and TIs used to perform all the sequences are listed in Table 1. (a) The T2-weighted turbo spin-echo (*TSE*) and T2-weighted short TI inversion-recovery (*STIR*) images were acquired before contrast agent administration. All techniques except T1-weighted spin-echo (*SE*) imaging were performed during breath holding. *IR-TFL* = inversion-recovery turboFLASH, *IR-TSE* = inversion-recovery turbo spin echo, *MD-FLASH* = magnetization-driven FLASH. (b) The segmented inversion-recovery turboFLASH (*Seg IR-TFL*) image demonstrates the highest contrast-to-noise ratio between the infarcted and normal myocardium; this was in agreement with the overall results. In a and b, the region of subendocardial infarction is indicated by the arrow on each image.

Cardiac Imaging

Orlando P. Simonetti, PhD
Raymond J. Kim, MD
David S. Fieno, PhD
Hanns B. Hillenbrand, MD, PhD
Edwin Wu, MD

An Improved MR Imaging Technique for the Visualization of Myocardial Infarction[1]

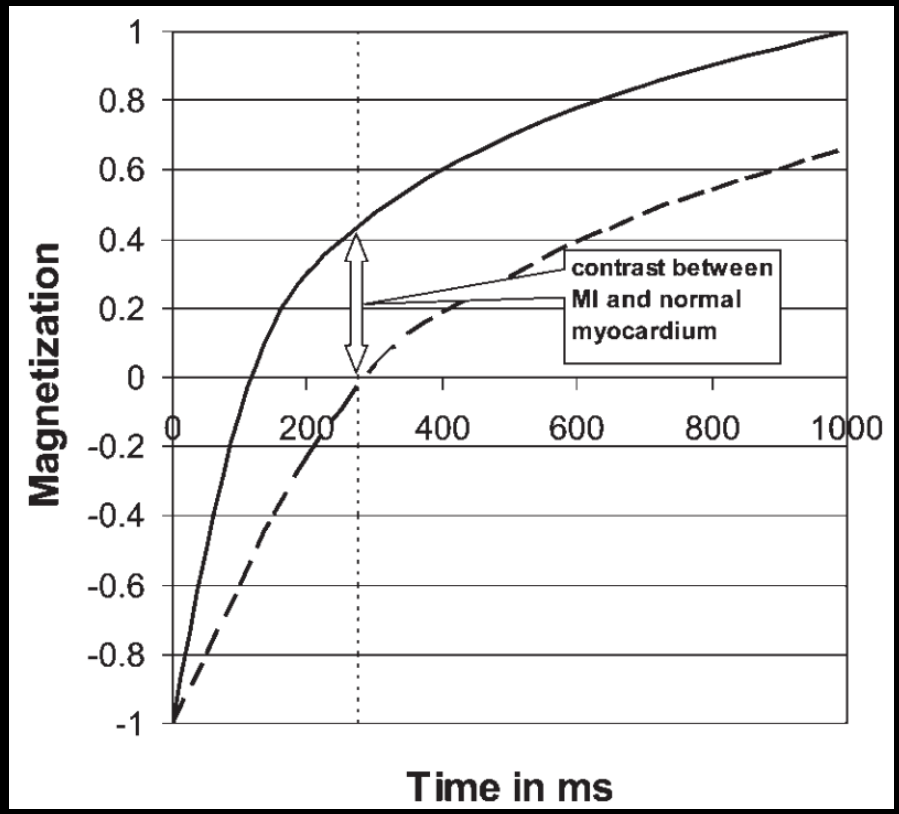


Simonetti OP. Radiology. 2001;218(1):215-23

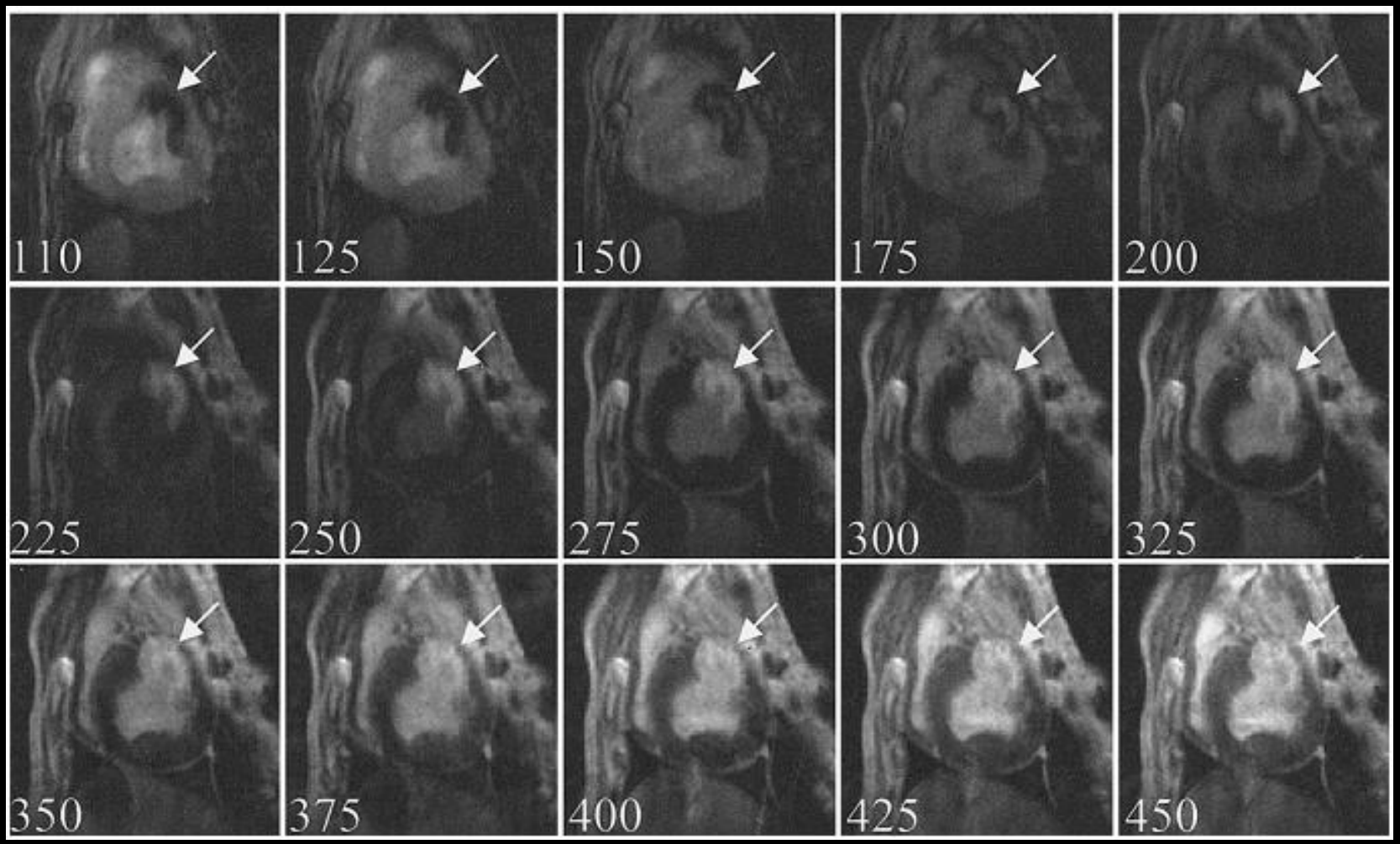
Técnica

- Factores que influyen en la dinámica de contraste:
  - Lavado de contraste del miocardio sano
  - Función cardíaca
  - Función renal
  - Cantidad de contraste

El tiempo de inversión se debe ajustar en cada paciente



Técnica – tiempo de inversión



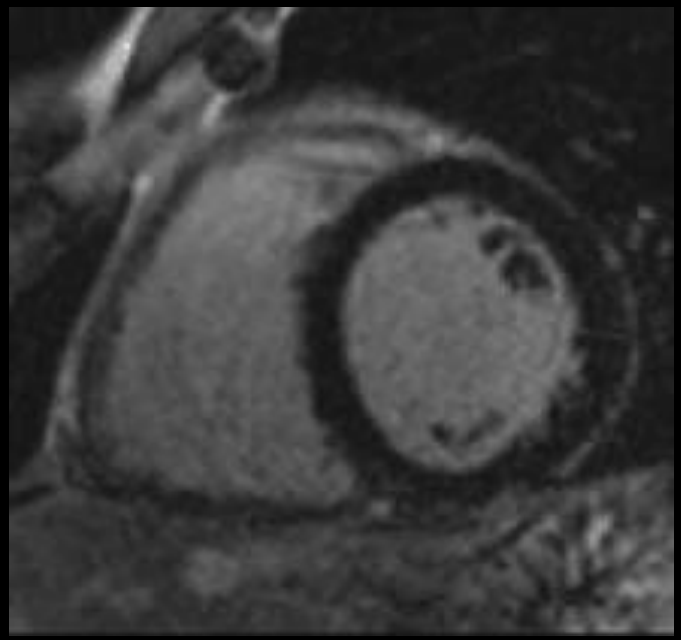
Simonetti OP. Radiology. 2001;218(1):215-23

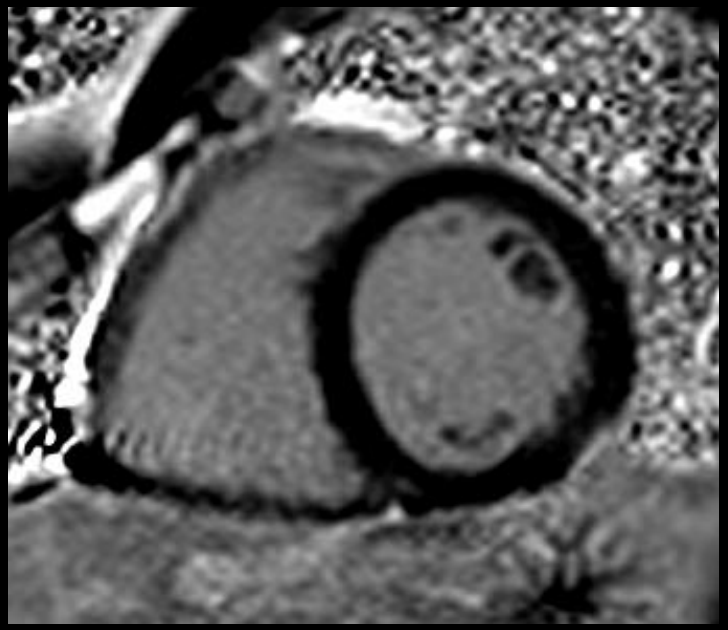
Técnica – tiempo de inversión

Magnetic Resonance in Medicine 47:372–383 (2002)

Phase-Sensitive Inversion Recovery for Detecting Myocardial Infarction Using Gadolinium-Delayed Hyperenhancement

Peter Kellman,* Andrew E. Arai, Elliot R. McVeigh, and Anthony H. Aletras





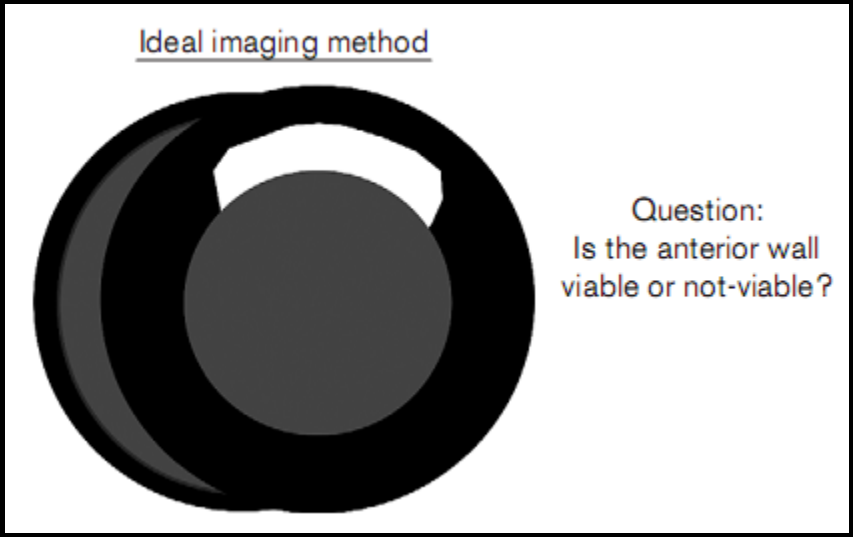
Kellman P.Magn Reson Med. 2002;47(2):372-83

Conceptos

"Bright is dead"

- La cicatriz o fibrosis se manifiesta como:
  - Áreas HIPERINTENSAS en las secuencias de realce tardío
  - Localización subendocárdica o transmural en un territorio coronario

- Como norma general, el miocardio con realce que afecte >50% espesor miocárdico (transmural), es poco probable que recupere su función contráctil tras revascularización



Elliott MD. Coron Artery Dis. 2005;16(6):365-72

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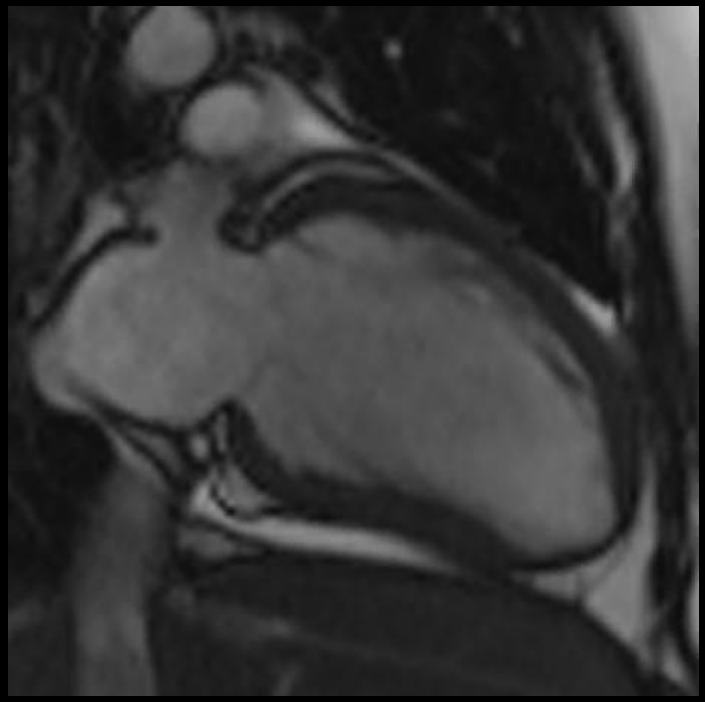
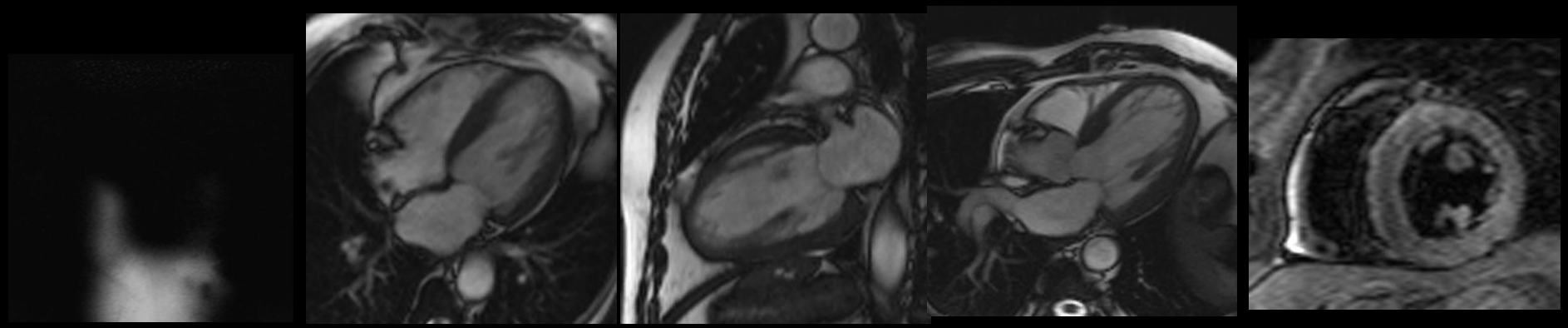
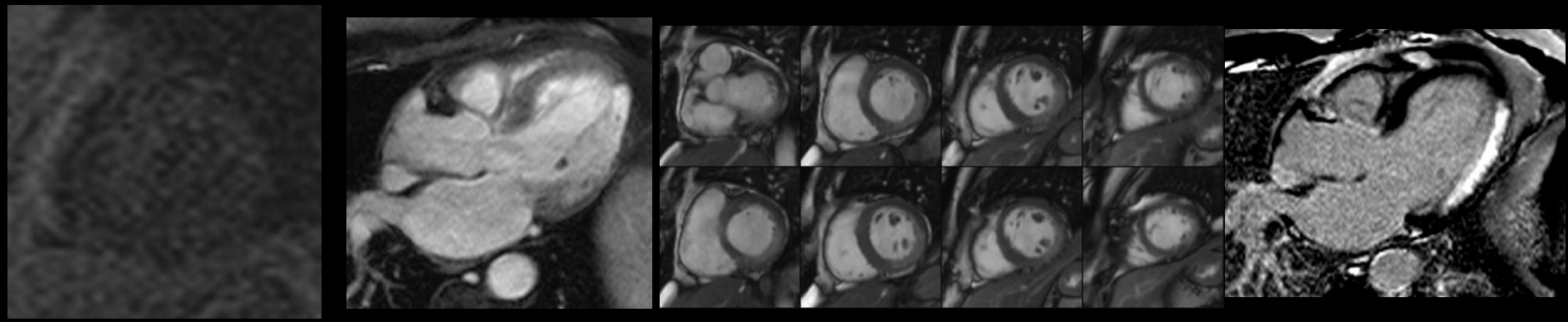
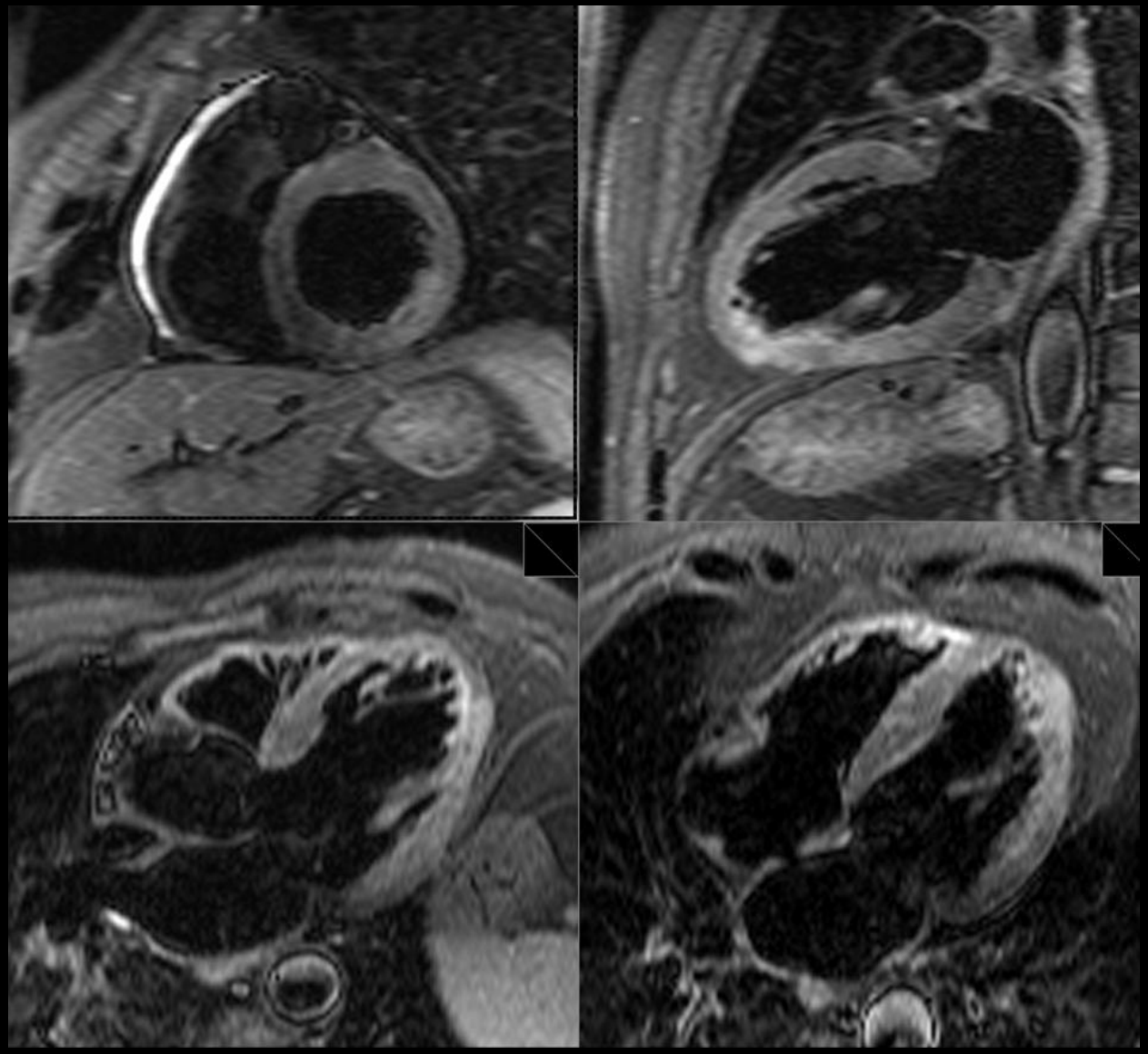


Protocolo de estudio – Infarto agudo de miocardio



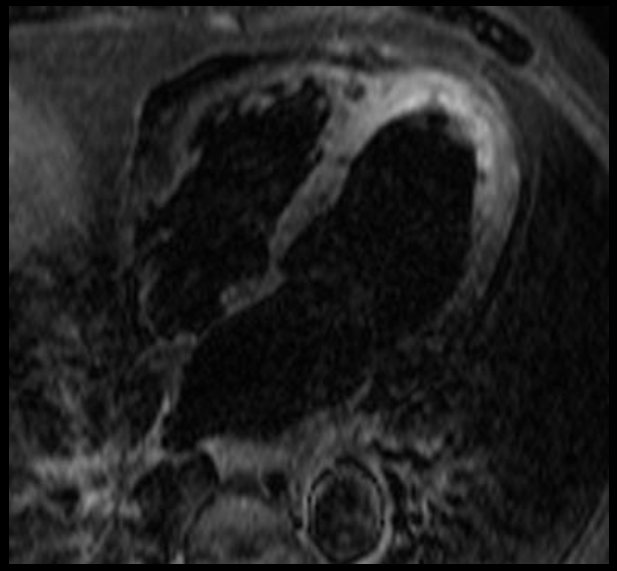


Detección de edema miocárdico



Detección de edema miocárdico

Infarto



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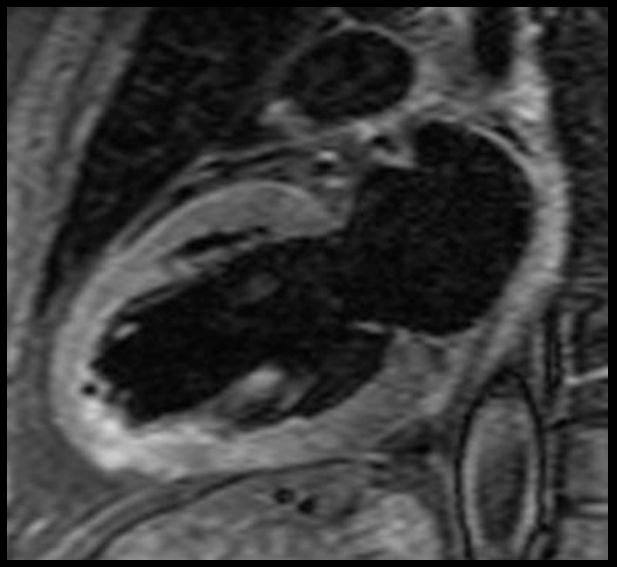
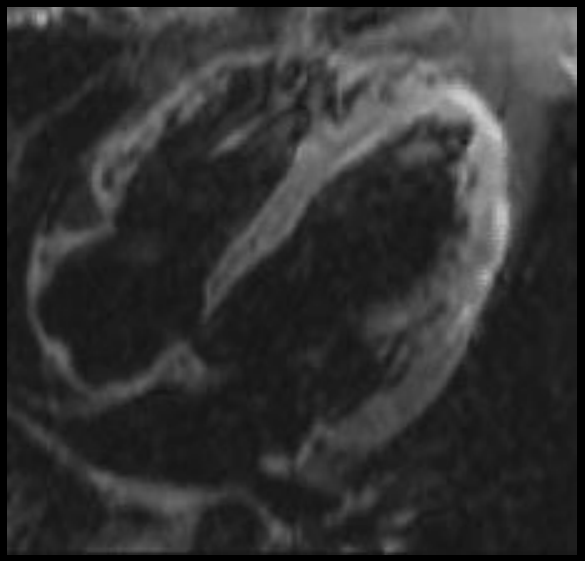


Miocarditis

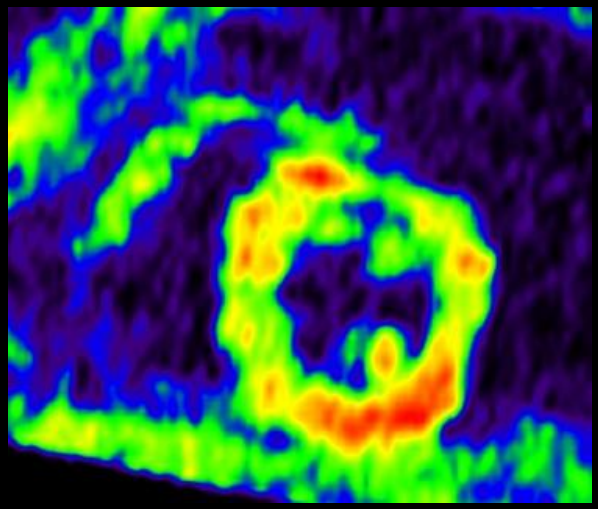


Detección de edema miocárdico

B50

B300

B800



ADC

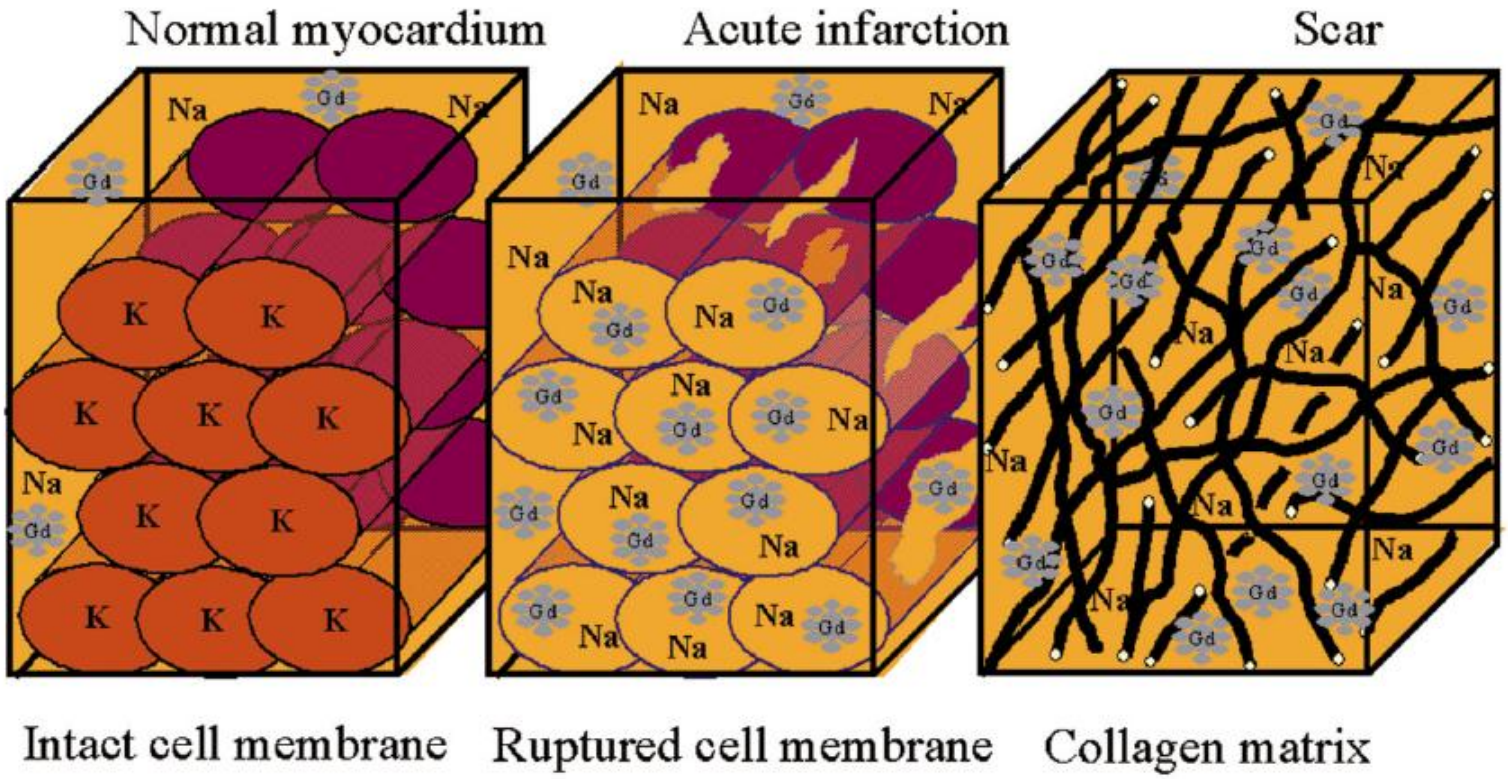
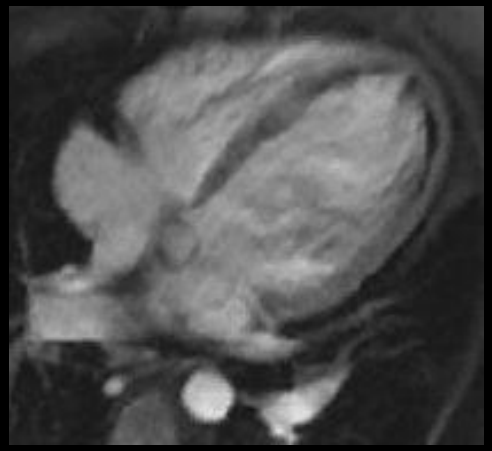


Figure 8. Potential mechanisms of hyperenhancement in acute and chronic MI. See text for details. (Reprinted with permission from Cardiovascular MRI and MRA. Charles B. Higgins, editor. Lippincott Williams & Wilkins, 2002.)

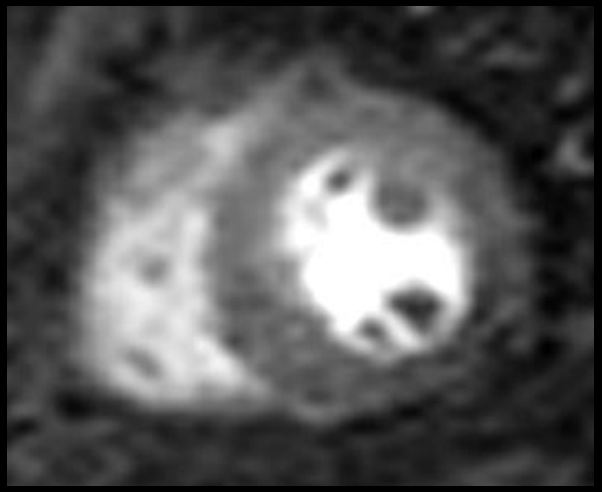
Obstrucción microvascular

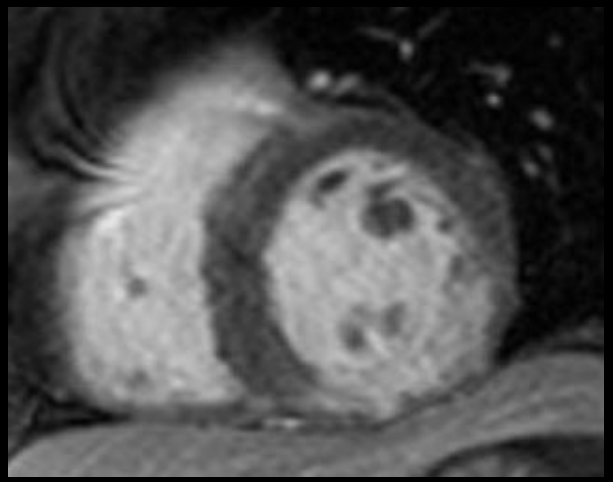


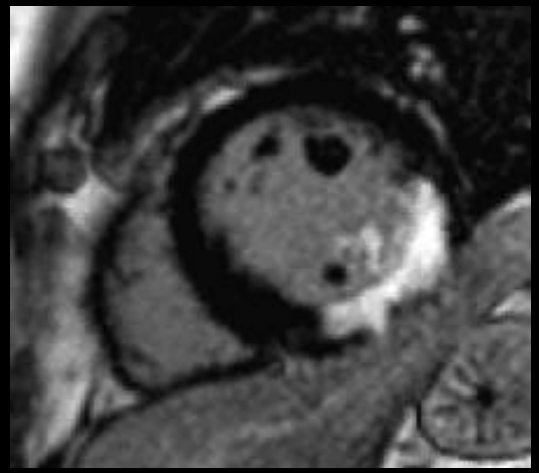
- Las áreas con obstrucción microvascular son no viables
- No recuperan su función 7-8 semanas post-infarto
- Marcador pronóstico de complicaciones post-infarto
- Mejor predictor de eventos cardiacos mayores que el tamaño del infarto definido por el realce tardío
- Remodelado ventricular tras infarto agudo

Hombach V. Eur Heart J. 2005;26(6):549-57
Rogers WJ Jr. Circulation. 1999;99(6):744-50
Choi CJ. J Cardiovasc Magn Reson. 2004;6(4):917-25

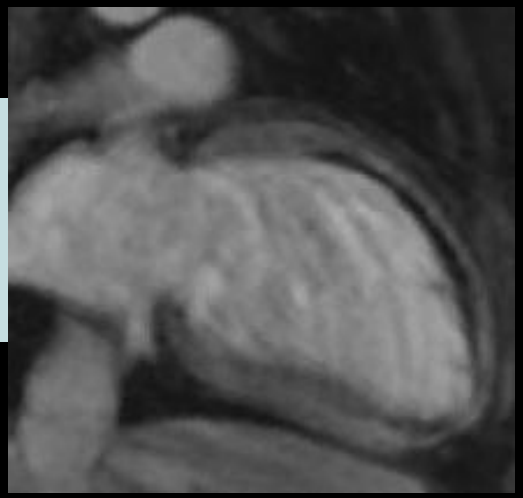
Detección de obstrucción microvascular

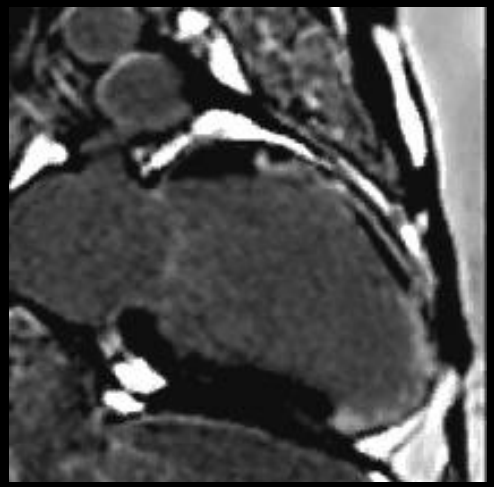






Conclusion: By using cardiac MR imaging, late hypoenhancement is the best prognostic marker of LV remodeling, with highest CNR between the infarcted myocardium and MVO regions.

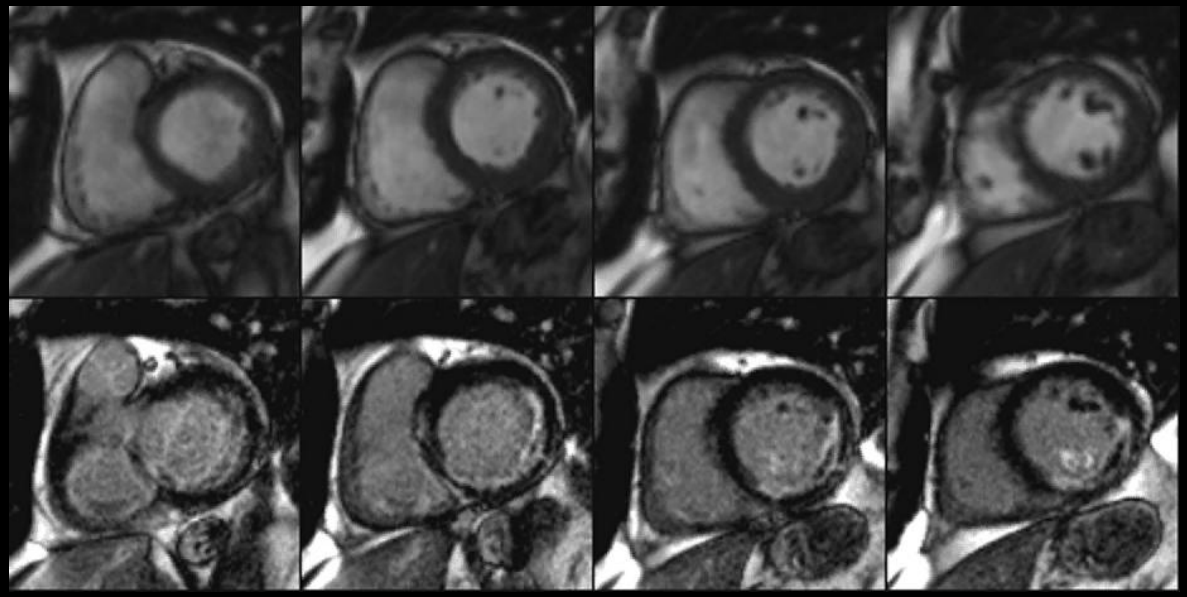




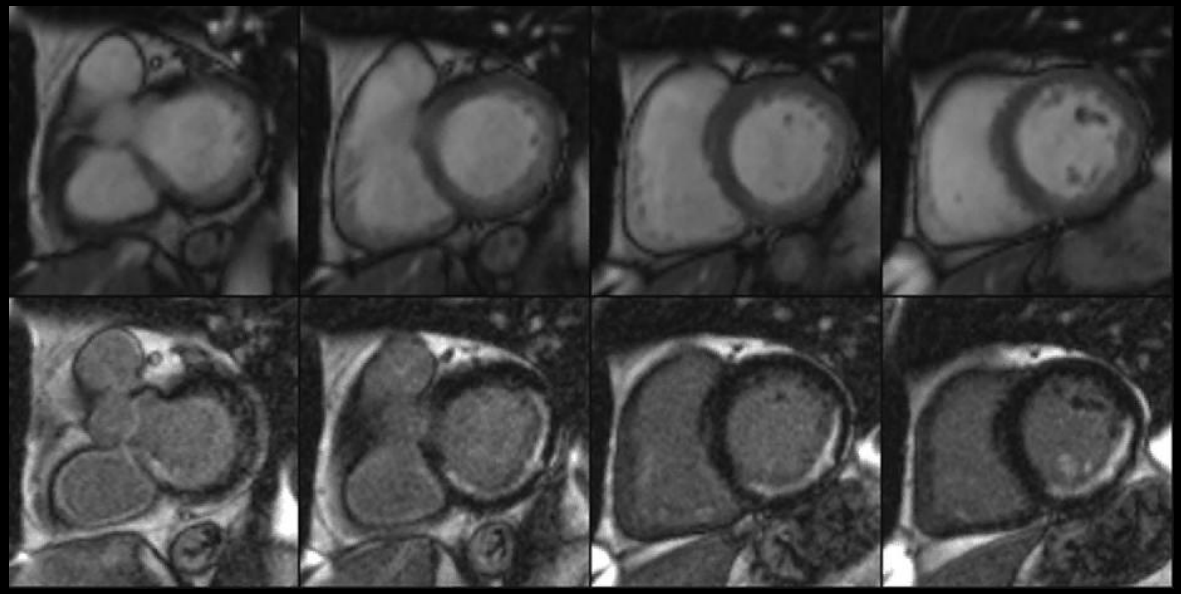
Nijveldt R. Radiology. 2009;250:363-70

Obstrucción microvascular

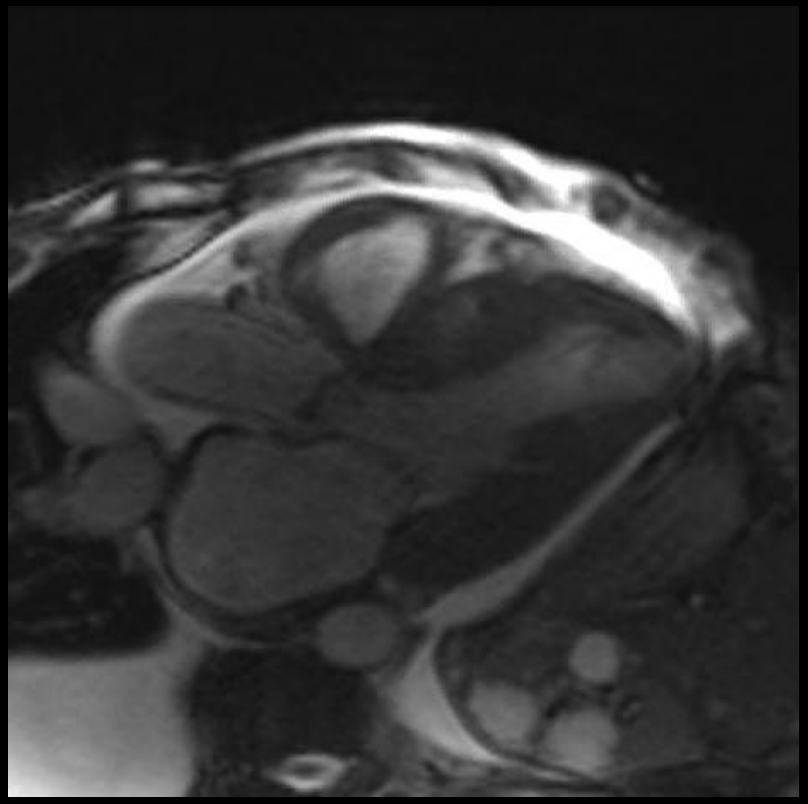
Basal

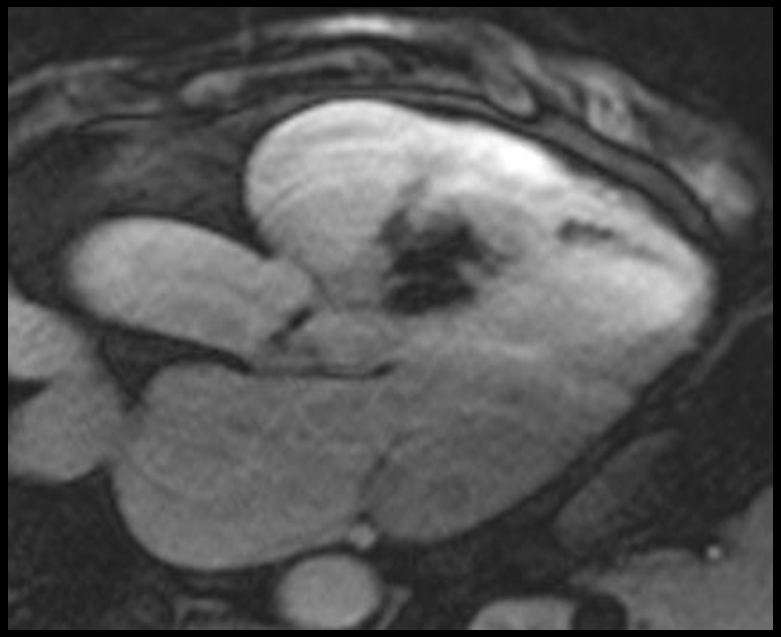


3 meses

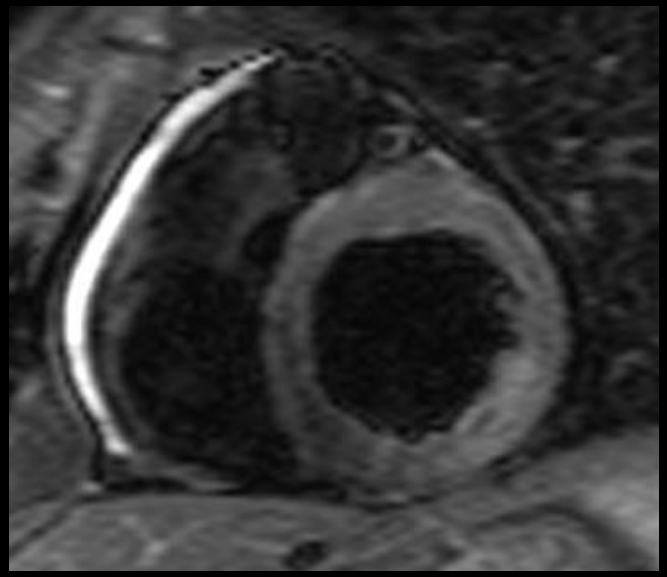


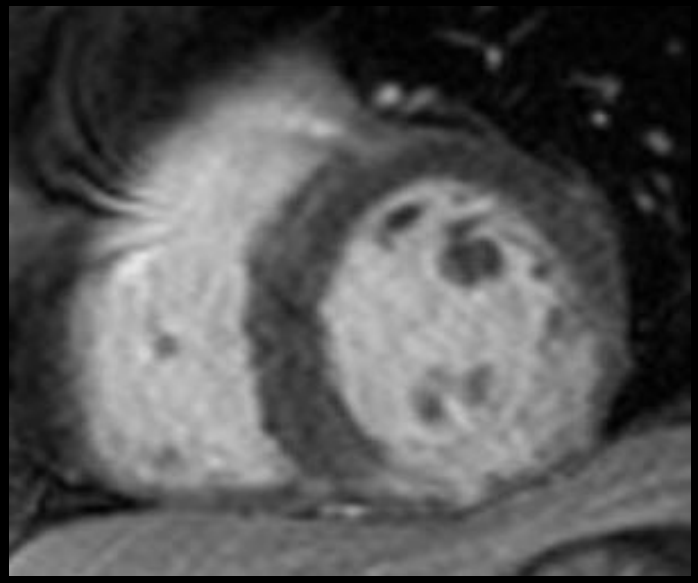
Detección de hemorragia miocárdica

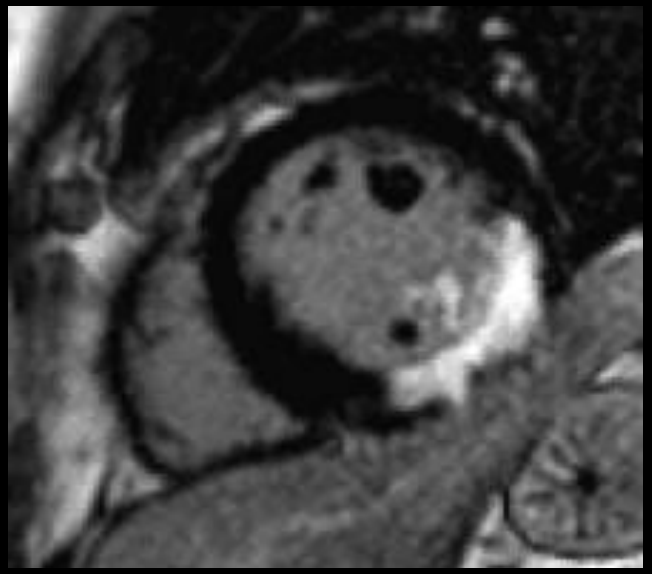




Extensión del infarto







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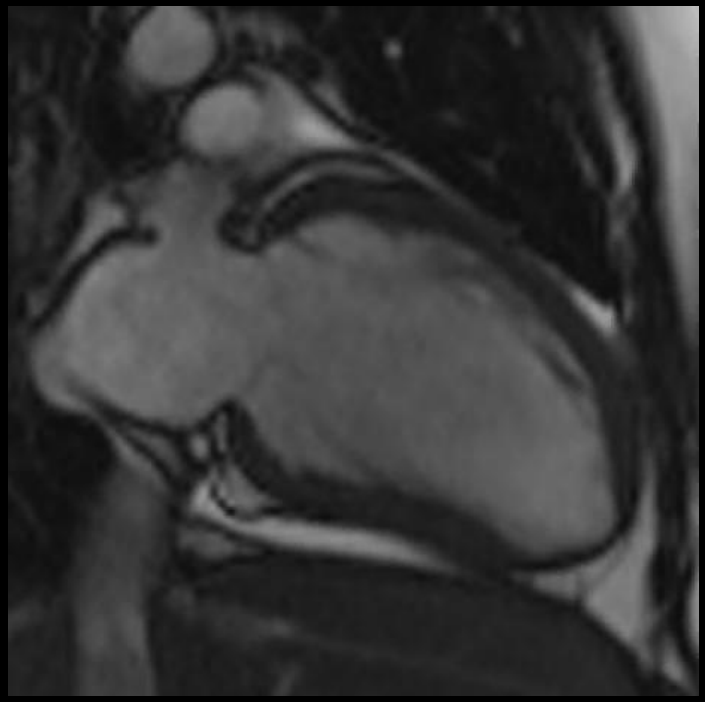
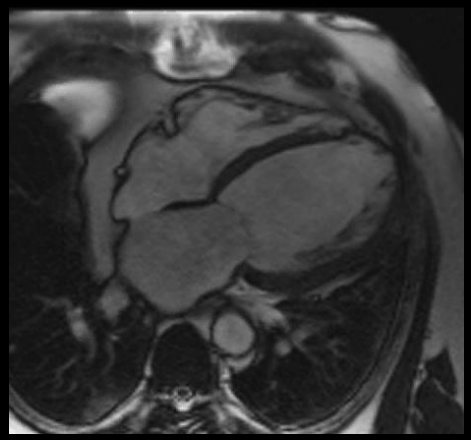
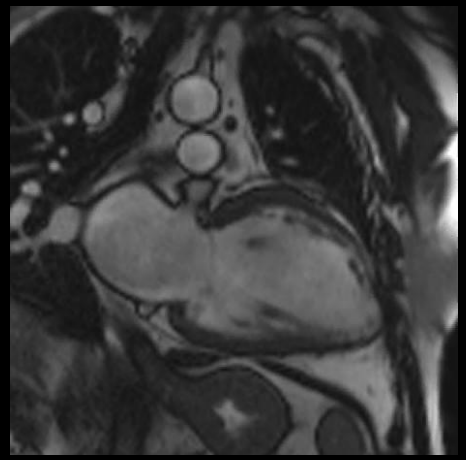
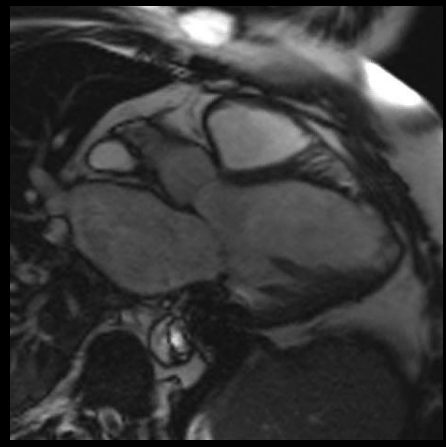
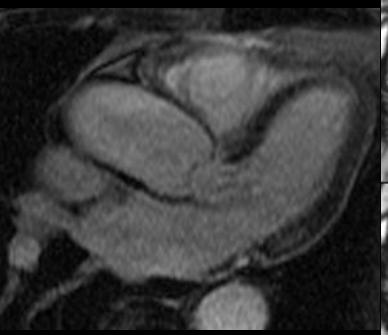
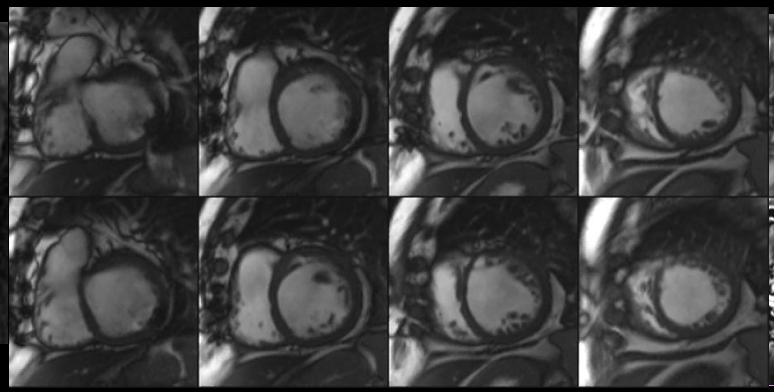
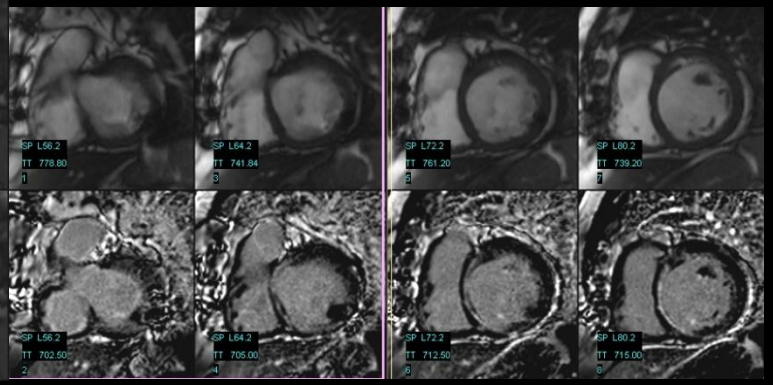
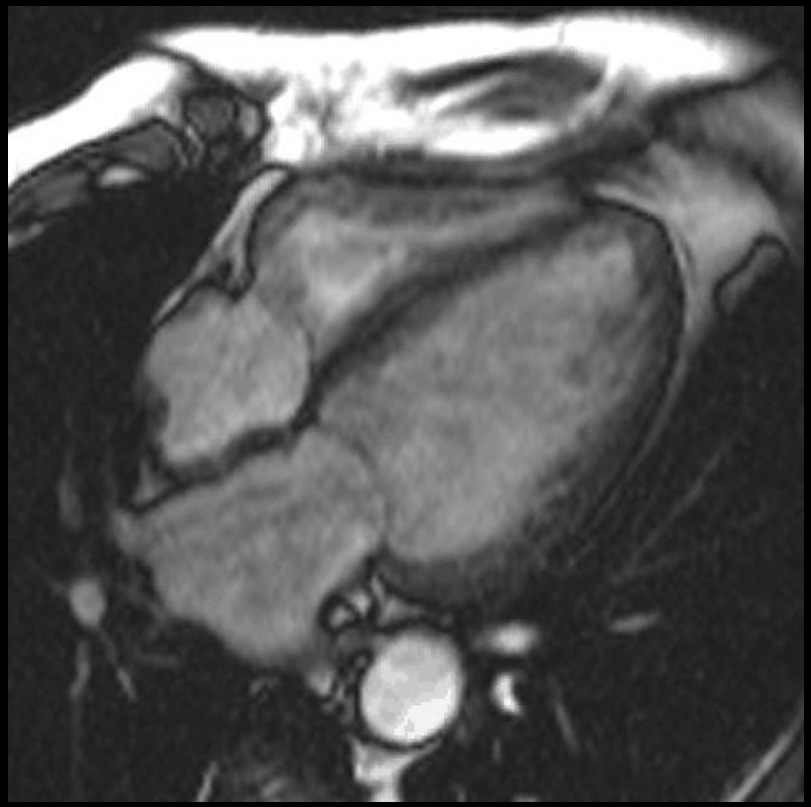


Protocolo de estudio – Infarto crónico

Trombo intracavitario



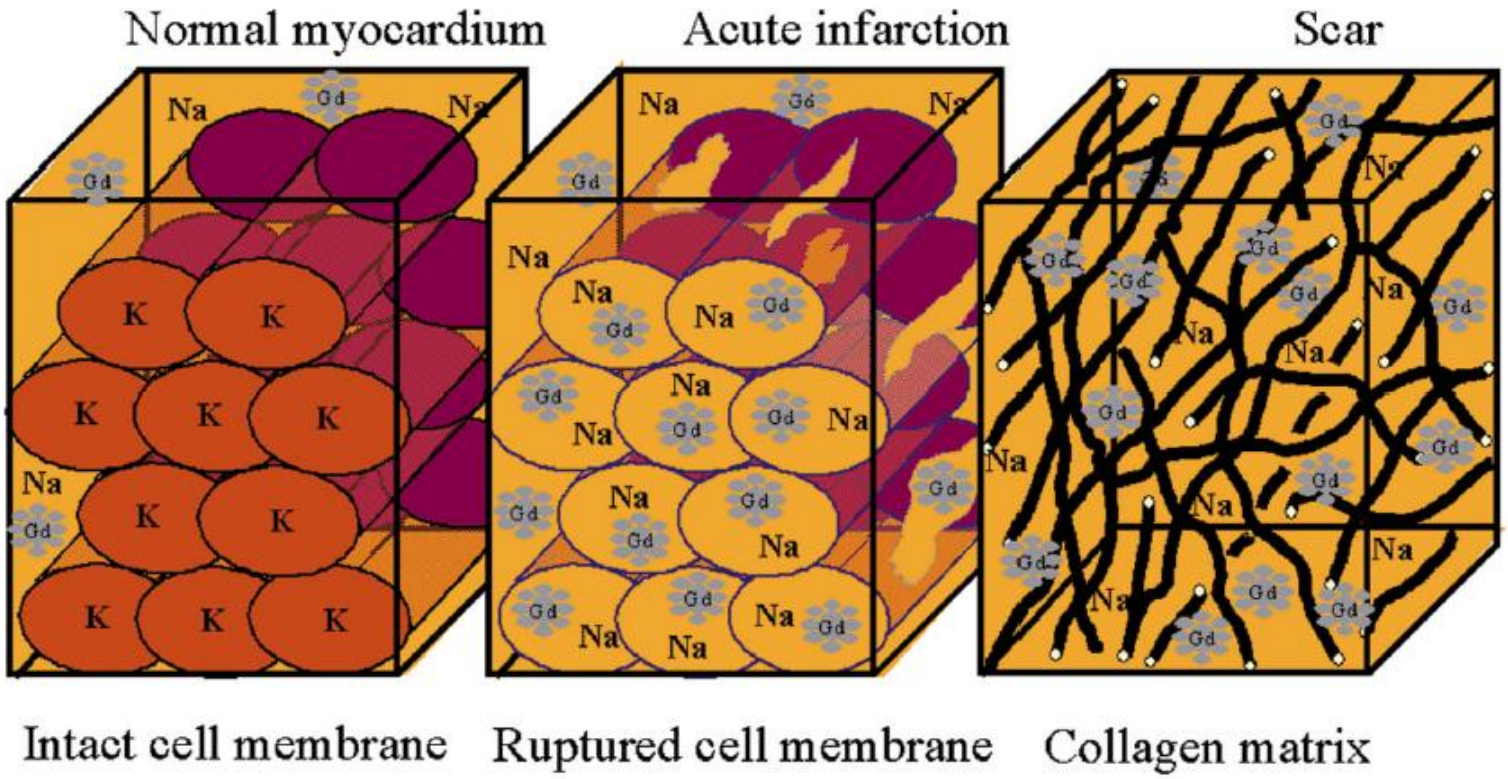
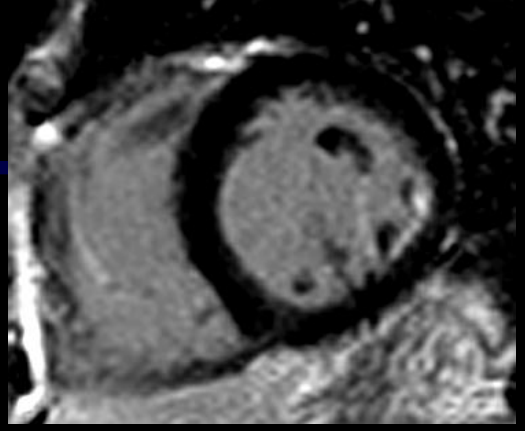
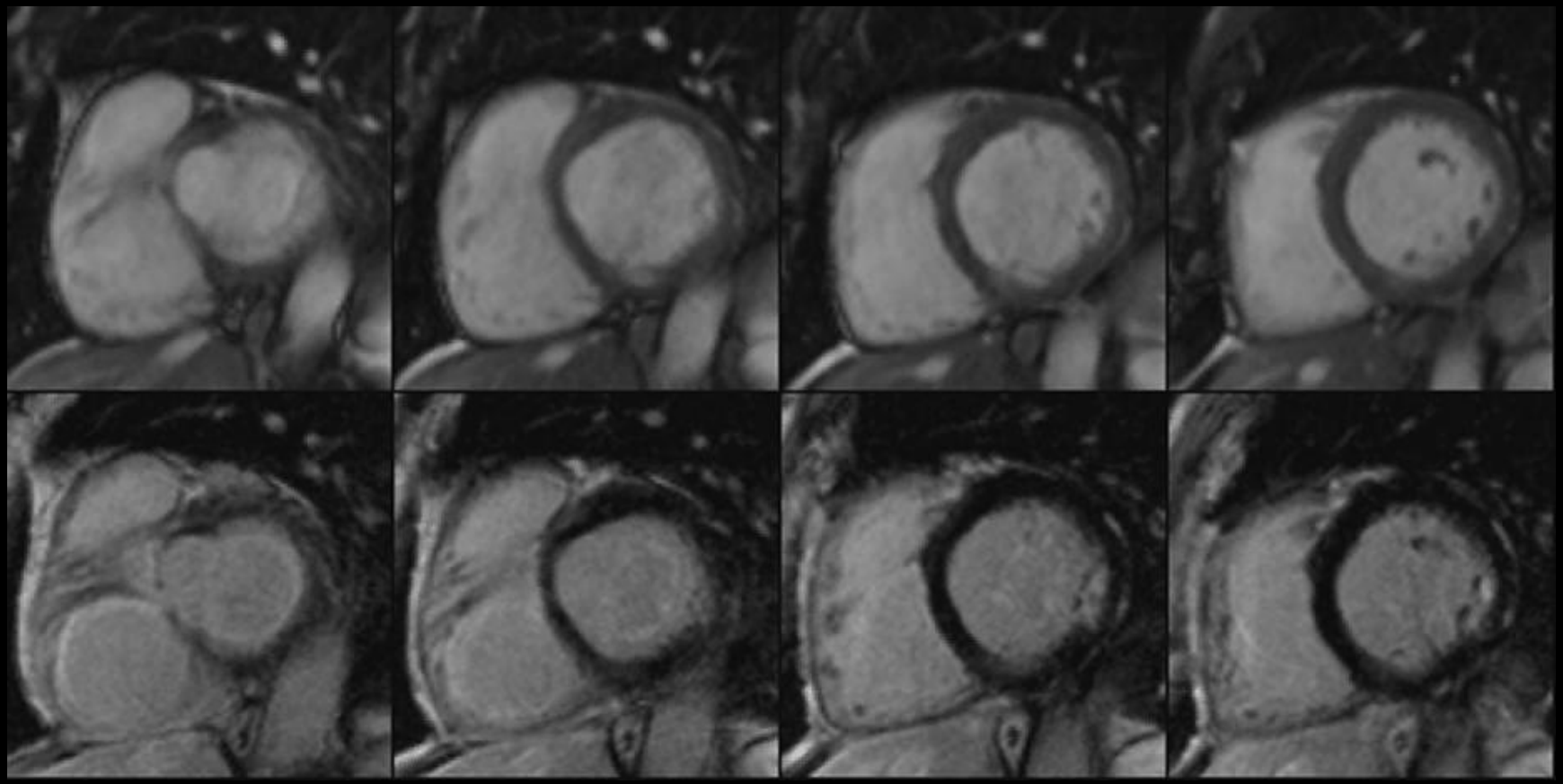


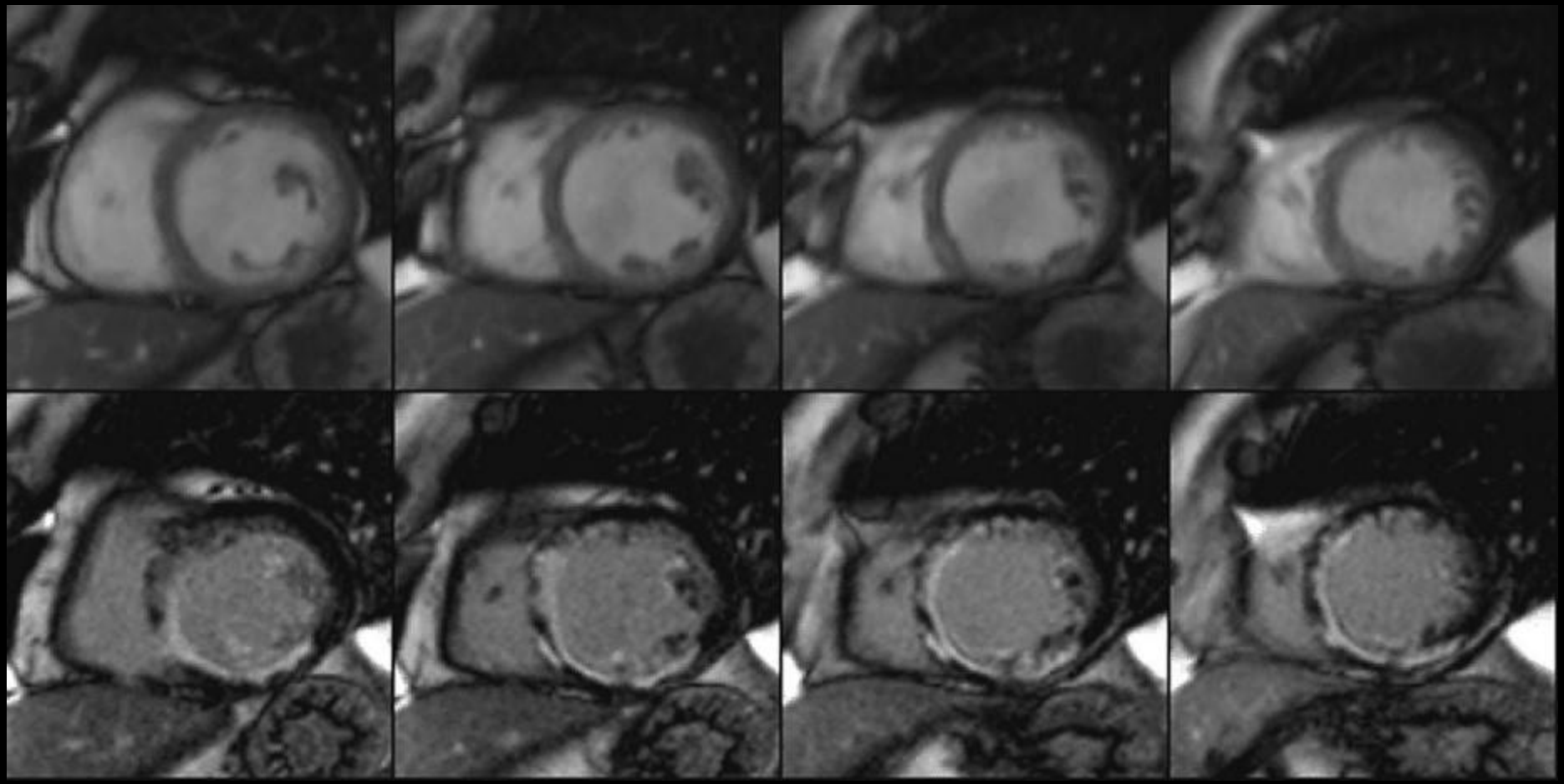
Figure 8. Potential mechanisms of hyperenhancement in acute and chronic MI. See text for details. (Reprinted with permission from Cardiovascular MRI and MRA. Charles B. Higgins, editor. Lippincott Williams & Wilkins, 2002.)

Extensión del infarto

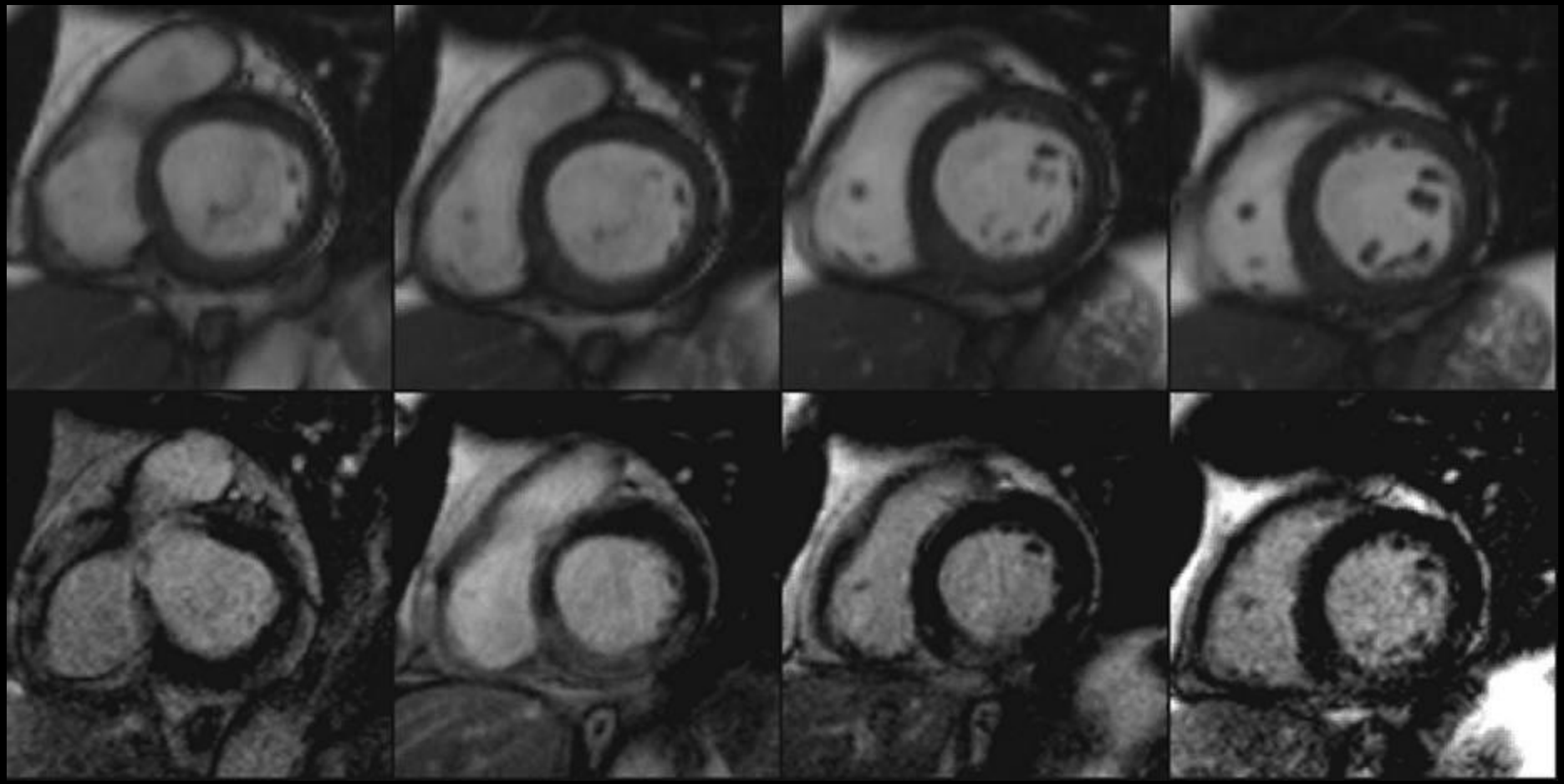




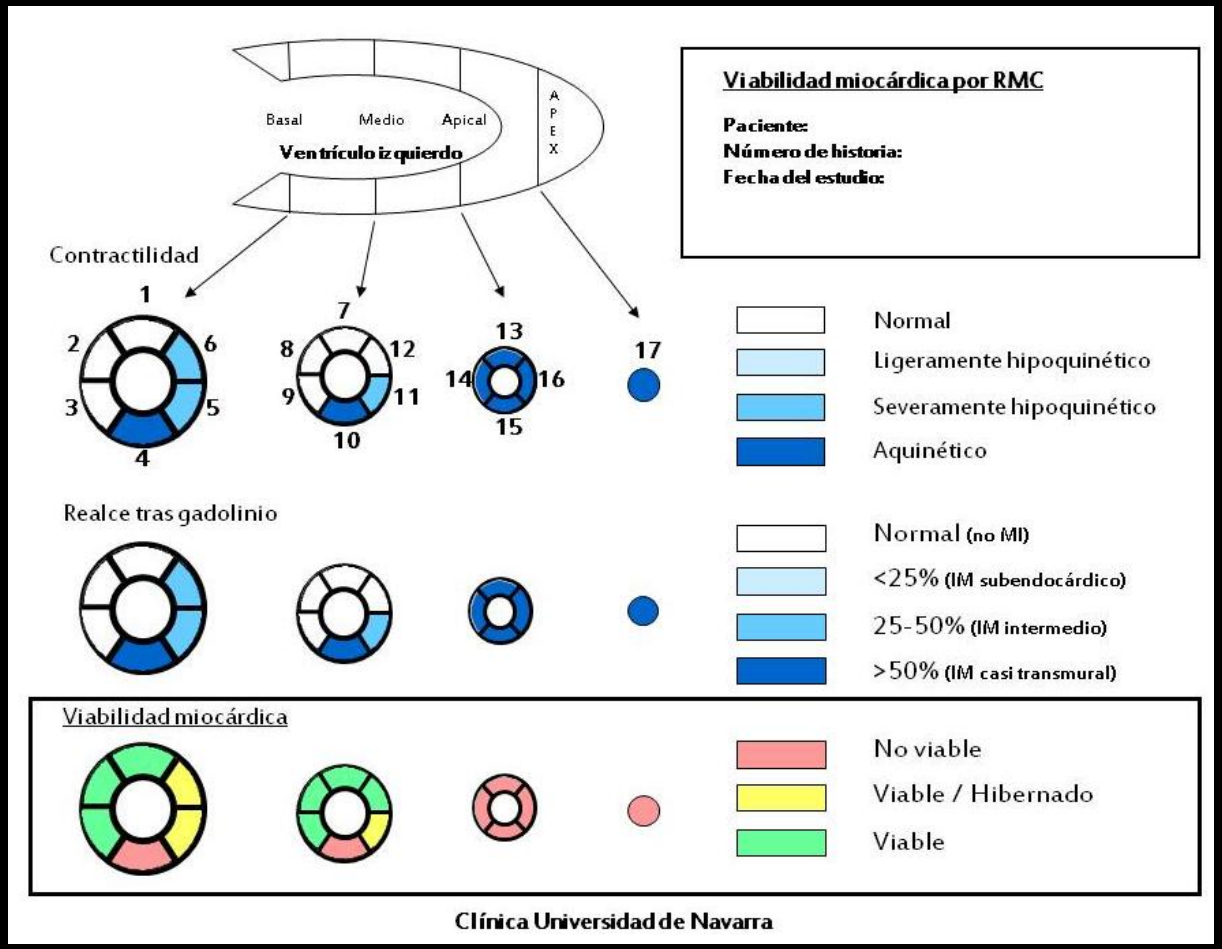
Extensión del infarto



Detección de zona “gris” peri-infarto



Cuantificación del infarto

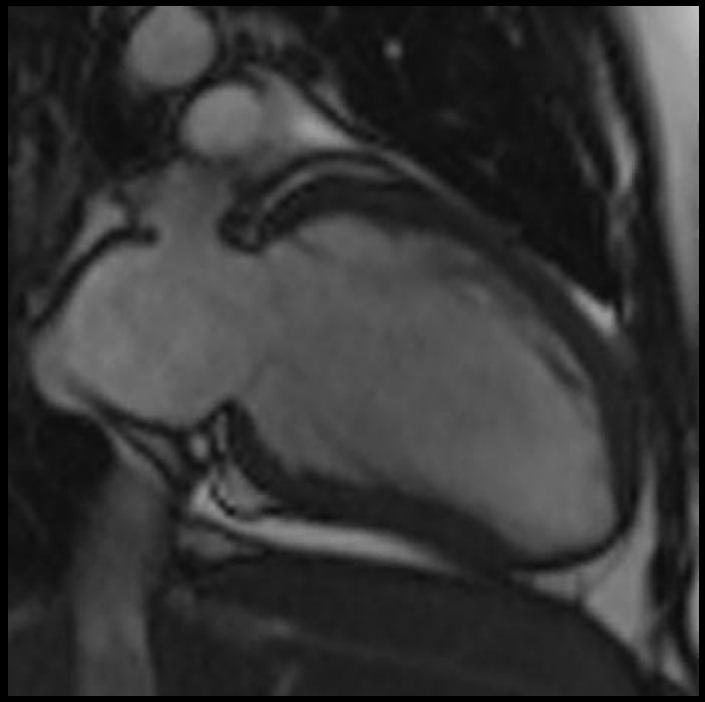


CRM e infarto de miocardio

Tipo de infarto	Perfusión en reposo	Realce tardío	Significado
Infarto agudo con reperfusión	Normal	Sí	A mayor transmuralidad del realce, menor probabilidad de recuperación funcional
Infarto agudo sin reperfusión	Hipointensidad ("core")	Sí	La obstrucción microvascular se asocia a mayor número de complicaciones (insuficiencia cardiaca, recurrencia infarto)
Miocardio aturdido	Normal	No	Buen pronóstico, recuperación funcional de estos segmentos miocárdicos
Infarto crónico	Normal – ligero retraso captación	Sí	Baja probabilidad de recuperación funcional si realce >50% grosor miocárdico
Miocardio hibernado	Normal	No	Buen pronóstico, recuperación funcional de estos segmentos miocárdicos tras revascularización

CRM en CI: Extensión y tamaño IAM y viabilidad

- Conceptos
- Protocolo de estudio
  - Infarto agudo
  - Infarto crónico
- Indicaciones CRM
- TCMC en cardiopatía isquémica



Indicaciones CRM en el infarto

- Función y masa ventricular
- Presencia, localización y extensión del infarto
- Probabilidad de recuperación funcional y remodelado ventricular tras infarto agudo de miocardio
- Viabilidad miocárdica pre-revascularización
- Secuelas de infarto:
  - Obstrucción microvascular
  - Derrame pericárdico
  - Trombo ventricular
  - Infarto de músculos papilares
  - Aneurisma/pseudoaneurisma
- Caracterización de los mecanismos de insuficiencia mitral:
  - Geometría del VI
  - Infarto de músculos papilares
  - Isquemia de músculos papilares y de la cara inferior del VI
- Necrosis miocárdica durante el procedimiento de revascularización
- Etiología isquémica/no isquémica en insuficiencia cardiaca

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doi:10.1016/j.jacc.2006.07.003

ACCF/ACR/SCCT/SCMR/ASNC/NASCI/SCAI/SIR APPROPRIATENESS CRITERIA

ACCF/ACR/SCCT/SCMR/ ASNC/NASCI/SCAI/SIR 2006 Appropriateness Criteria for Cardiac Computed Tomography and Cardiac Magnetic Resonance Imaging*

A Report of the American College of Cardiology Foundation Quality Strategic Directions Committee Appropriateness Criteria Working Group, American College of Radiology, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, American Society of Nuclear Cardiology, North American Society for Cardiac Imaging, Society for Cardiovascular Angiography and Interventions, and Society of Interventional Radiology

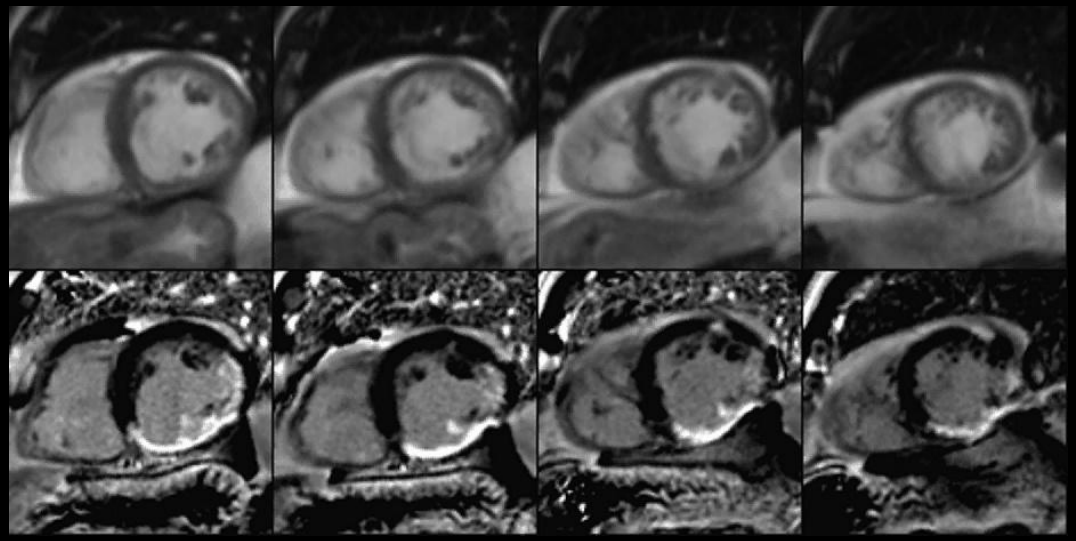

Table 17. Detection of Myocardial Scar and Viability

Indication		Appropriateness Criteria (Median Score)
Evaluation of Myocardial Scar (Use of Late Gadolinium Enhancement)		
30.	• To determine the location and extent of myocardial necrosis including 'no reflow' regions • Post-acute myocardial infarction	A (7)
31.	• To detect post PCI myocardial necrosis	U (4)
32.	• To determine viability prior to revascularization • Establish likelihood of recovery of function with revascularization (PCI or CABG) or medical therapy	A (9)
33.	• To determine viability prior to revascularization • Viability assessment by SPECT or dobutamine echo has provided "equivocal or indeterminate" results	A (9)

Hendel RC. J Am Coll Cardiol. 2006;48(7):1475-97.

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Published by Elsevier Inc.
Vol. 55, No. 23, 2010
ISSN 0735-1097/$36.00
doi:10.1016/j.jacc.2009.11.011

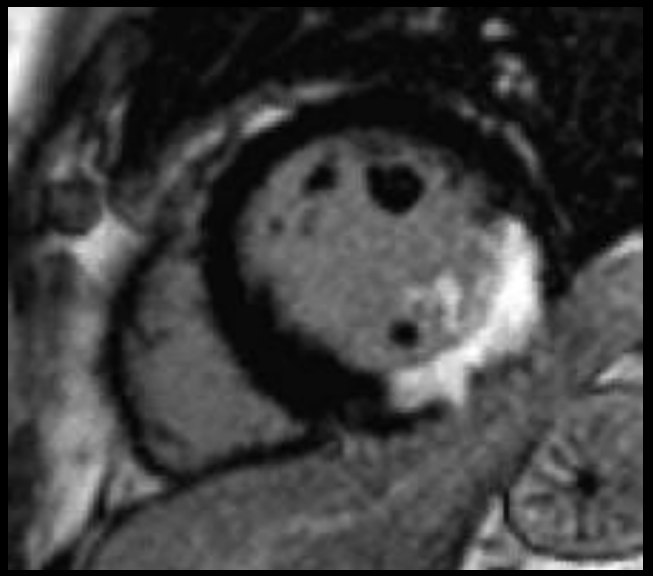
EXPERT CONSENSUS DOCUMENT

ACCF/ACR/AHA/NASCI/SCMR 2010 Expert Consensus Document on Cardiovascular Magnetic Resonance

A Report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents

3.4. Myocardial Infarction/Scar

LGE-CMR can be used for identifying the extent and location of myocardial necrosis in individuals suspected of having or possessing chronic or acute ischemic heart disease.



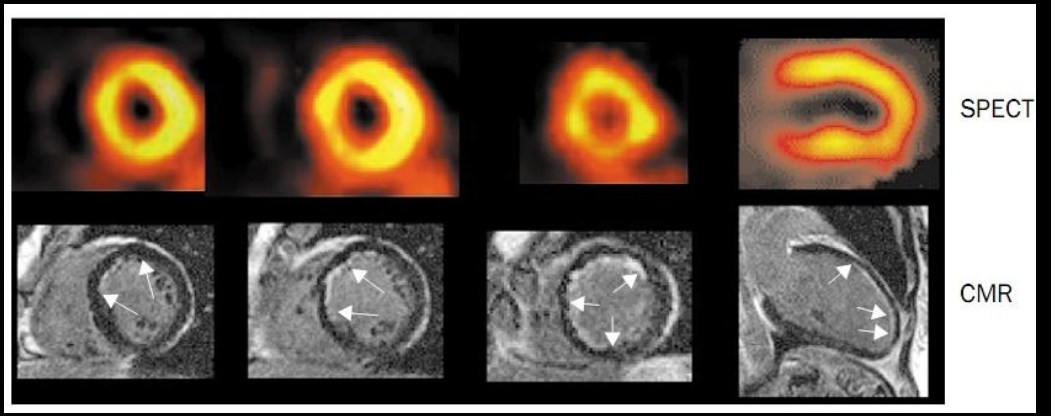
Hundley WG. J Am Coll Cardiol. 2010;55(23):2614-62

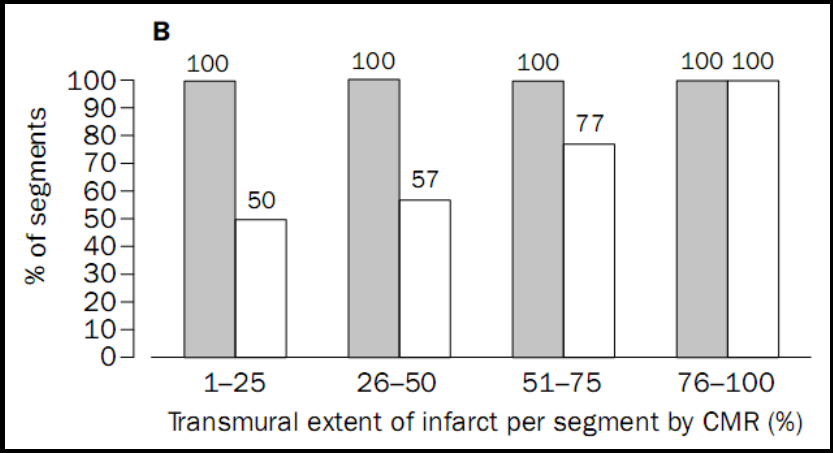
El realce tardío por RM es superior al SPECT para detectar la extensión del IM

ARTICLES

Contrast-enhanced MRI and routine single photon emission computed tomography (SPECT) perfusion imaging for detection of subendocardial myocardial infarcts: an imaging study

Anja Wagner, Heiko Mahrholdt, Thomas A Holly, Michael D Elliott, Matthias Regenfus, Michele Parker, Francis J Klocke, Robert O Bonow, Raymond J Kim, Robert M Judd





- Transmuralidad del infarto de miocárdico con SPECT y RM
  - Similar en infartos transmurales
  - Mayor detección de infartos subendocárdicos mediante RM

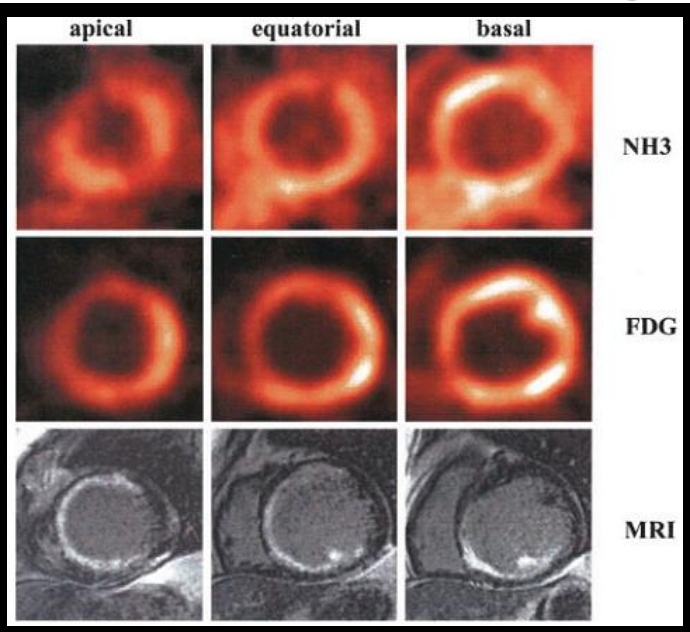
Wagner A. Lancet. 2003;361(9355):374-9.

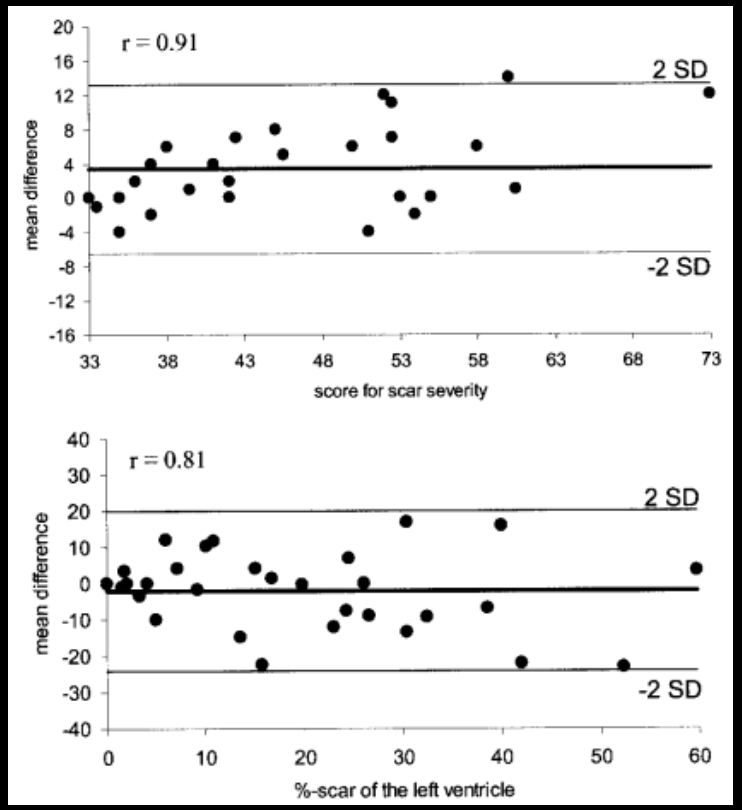
El realce tardío por RM es similar al PET para detectar la extensión del IM

Assessment of Myocardial Viability With Contrast-Enhanced Magnetic Resonance Imaging

Comparison With Positron Emission Tomography

Christoph Klein, MD; Stephan G. Nekolla, PhD; Frank M. Bengel, MD; Mitsuru Momose, MD; Andrea Sammer, MD; Felix Haas, MD; Bernhard Schnackenburg, PhD; Wolfram Delius, MD; Harald Mudra, MD; Dieter Wolfram, MD; Markus Schwaiger, MD





- Transmuralidad del infarto de miocárdico con PET y RM
  - Similar en infartos transmurales
  - Mayor detección de infartos subendocárdicos mediante RM

Klein C. Circulation. 2002;105(2):162-7.

Realce tardío para predecir la mejoría funcional tras IAM

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Vol. 42, No. 5, 2003
ISSN 0735-1097/03/$30.00
doi:10.1016/S0735-1097(03)00835-0

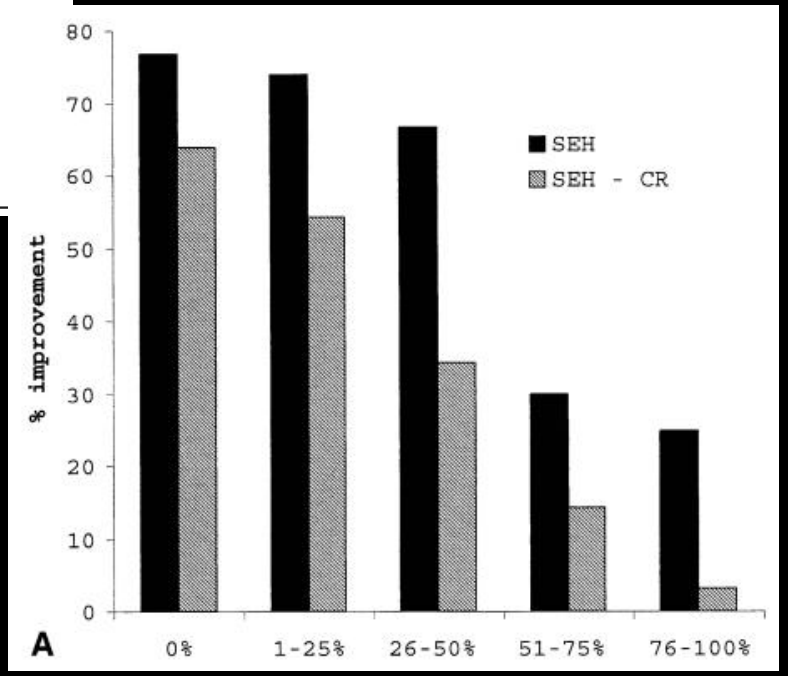
Cardiac Magnetic Resonance Imaging

Delayed Contrast-Enhanced Magnetic Resonance Imaging for the Prediction of Regional Functional Improvement After Acute Myocardial Infarction

Aernout M. Beek, MD,* Harald P. Kühl, MD,* Olga Bondarenko, MD,* Jos W. R. Twisk, PHD,† Mark B. M. Hofman, PHD,‡ Willem G. van Dockum, MD,* Cees A. Visser, MD, PHD,* Albert C. van Rossum, MD, PHD*

Amsterdam, The Netherlands

In patients with recent reperfused MI, functional improvement of stunned myocardium is predicted by DCE-MRI.



- El realce tardío predice la recuperación funcional del miocardio aturdido
- La probabilidad de mejoría / recuperación completa es inversamente proporcional a la transmuralidad del realce tardío

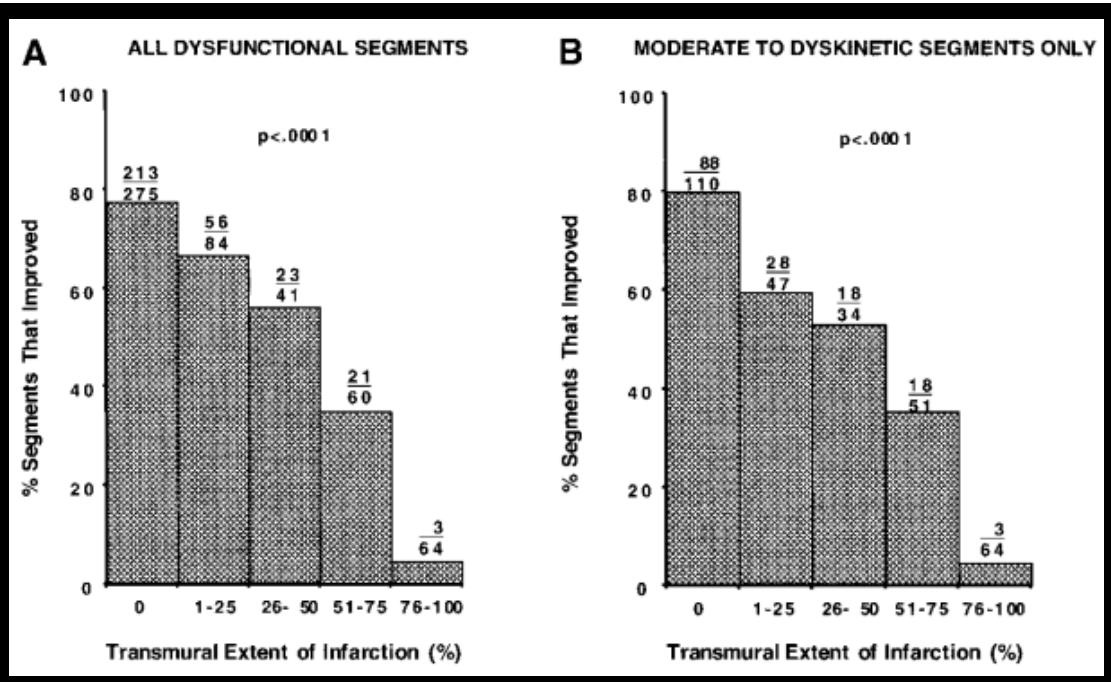
Beek AM. J Am Coll Cardiol. 2003;42(5):895-901

Realce tardío para predecir la mejoría funcional tras IAM

Clinical Investigation and Reports

Transmural Extent of Acute Myocardial Infarction Predicts Long-Term Improvement in Contractile Function

Kelly M. Choi, MD; Raymond J. Kim, MD; George Gubernikoff, MD; John D. Vargas, BS; Michelle Parker, MS, RN; Robert M. Judd, PhD



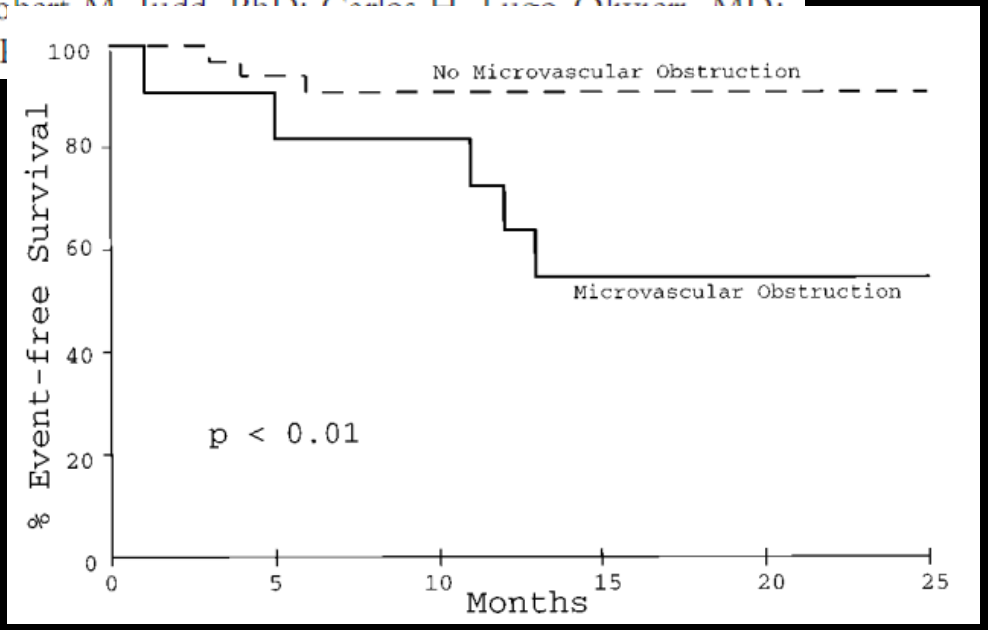
- La probabilidad de mejoría / recuperación completa es inversamente proporcional a la transmuralidad del realce tardío

Choi KM. Circulation. 2001;104(10):1101-7

Significado pronóstico de la obstrucción microvascular (MVO) mediante cardio-RM

Prognostic Significance of Microvascular Obstruction by Magnetic Resonance Imaging in Patients With Acute Myocardial Infarction

Katherine C. Wu, MD; Elias A. Zerhouni, MD; Robert M. Judd, PhD; Carlos H. Lugo-Olivieri, MD; Lili A. Barouch, MD; Steven P. Schulman, MD; I



- La presencia de obstrucción microvascular (MVO) predice las complicaciones cardiovasculares en los 2 primeros años tras el infarto

Wu KC. Circulation. 1998;97(8):765-72

Significado pronóstico de la obstrucción microvascular (MVO) mediante cardio-RM

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ISSN 0735-1097/08/$34.00
doi:10.1016/j.jacc.2008.04.006

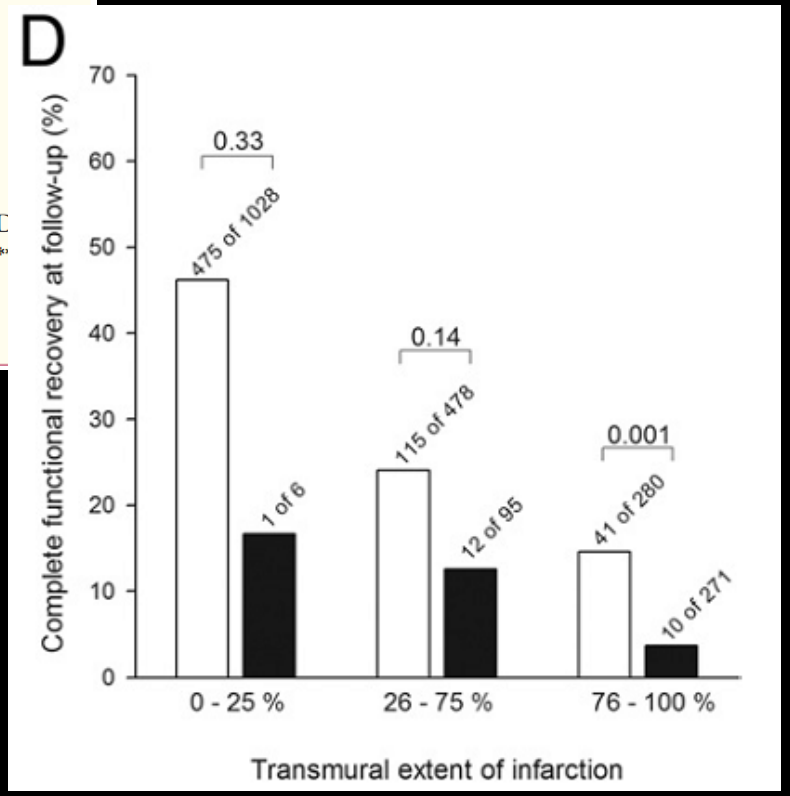
CLINICAL RESEARCH — Myocardial Infarction

Functional Recovery After Acute Myocardial Infarction

Comparison Between Angiography, Electrocardiography, and Cardiovascular Magnetic Resonance Measures of Microvascular Injury

Robin Nijveldt, MD,*§ Aernout M. Beek, MD,* Alexander Hirsch, MD,§|| Martin G. Stoel, MD,
Mark B. M. Hofman, PHD,† Victor A. W. M. Umans, MD, PHD,# Paul R. Algra, MD, PHD,*
Jos W. R. Twisk, PHD,‡ Albert C. van Rossum, MD, PHD*§
Amsterdam, Utrecht, Enschede, and Alkmaar, the Netherlands

In patients after revascularized AMI, late MVO proved a more powerful predictor of global and regional functional recovery than all of the other characteristics, including transmural extent of infarction



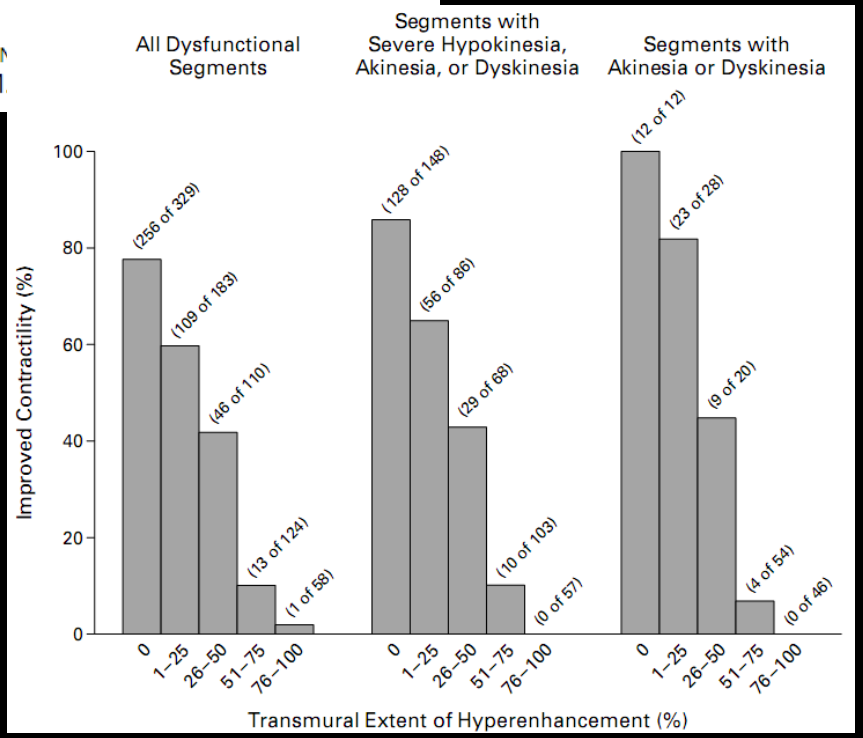
- La obstrucción microvascular (MVO) es el predictor más importante de los cambios en VTD, VTS y FE durante el seguimiento
- Posee un valor diagnóstico añadido a la extensión transmural del infarto

Nijveldt R. J Am Coll Cardiol. 2008;52(3):181-9.

El realce tardío identifica la disfunción miocárdica reversible pre-revascularización

THE USE OF CONTRAST-ENHANCED MAGNETIC RESONANCE IMAGING TO IDENTIFY REVERSIBLE MYOCARDIAL DYSFUNCTION

RAYMOND J. KIM, M.D., EDWIN WU, M.D., ALLEN RAFAEL, M.D., ENN-LING CHEN
ORLANDO SIMONETTI, PH.D., FRANCIS J. KLOCKE, M.D., ROBERT O. BONOW, M.

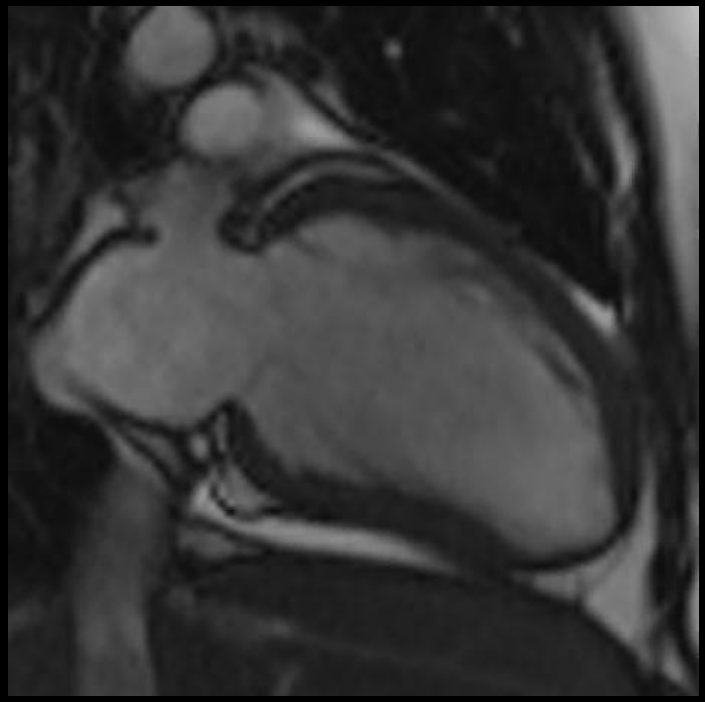


- Mediante el realce tardío se puede identificar la disfunción miocárdica reversible
- La probabilidad de mejoría en la contractilidad tras la revascularización es inversamente proporcional a la transmuralidad del realce tardío

Kim RJ. N Engl J Med. 2000;343(20):1445-53

CRM en CI: Extensión y tamaño IAM y viabilidad

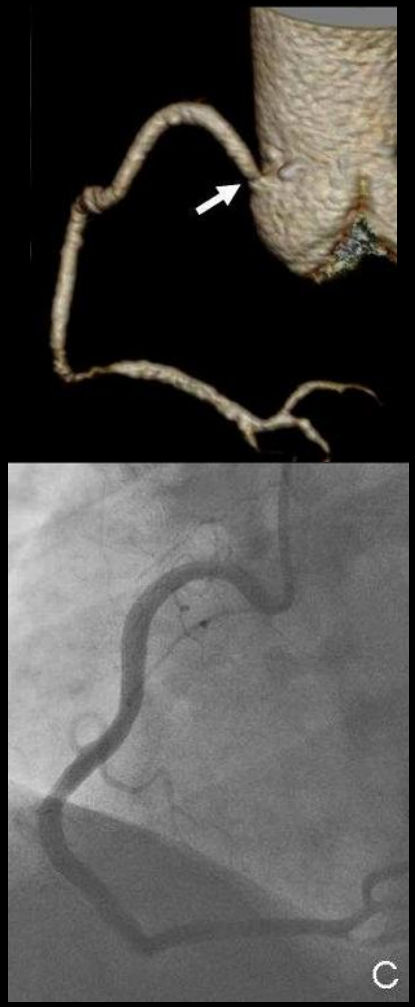
- Conceptos
- Protocolo de estudio
  - Infarto agudo
  - Infarto crónico
- Indicaciones CRM



- TCMC en cardiopatía isquémica

TCMC en la cardiopatía isquémica

- Significado fisiológico de la estenosis coronaria
- La calcificación coronaria dificulta la interpretación de los estudios de TCMC



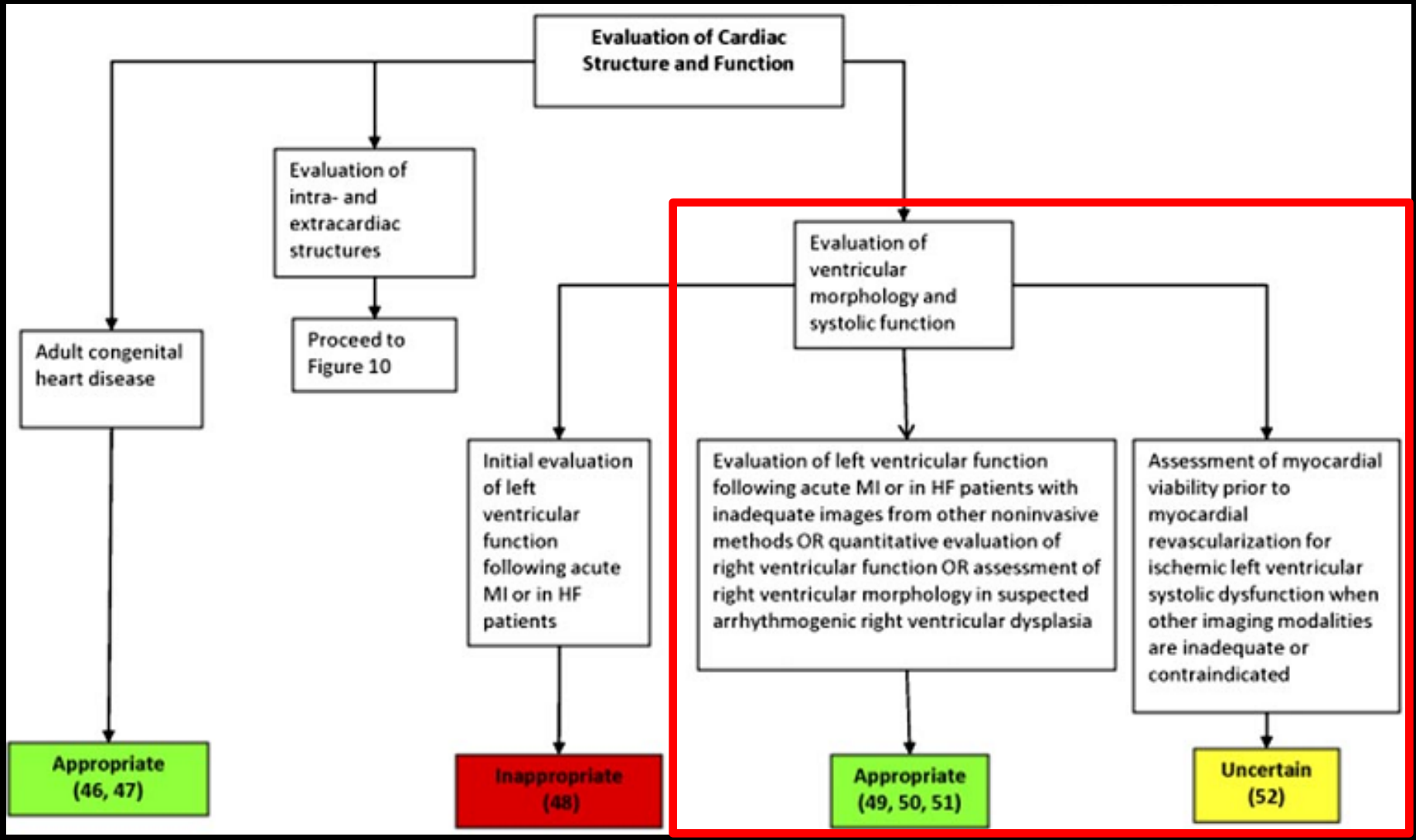
Accuracy of 64-Section CT and Dual-Source CT for Detection of Coronary Stenosis in Comparison with Conventional Coronary Angiography (Per-segment Analysis)

Author	Scanner Type	No. of Patients	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Raff et al (67)	64-Section CT	70	86	95	66	98
Leschka et al (66)	64-Section CT	67	94	97	87	99
Mollet et al (69)	64-Section CT	51	99	95	76	99
Fine et al (68)	64-Section CT	66	95	96	97	92
Ropers et al (73)	64-Section CT	81	93	97	56	100
Ehara et al (70)	64-Section CT	69	90	94	89	95
Ong et al (72)	64-Section CT	134	82	96	79	96
Oncel et al (71)	64-Section CT	80	96	98	91	99
Meijboom et al (77)	64-Section CT	360	88	90	47	99
Weustink et al (76)	Dual-Source CT	100	95	95	75	99
Johnson et al (75)	Dual-Source CT	35	88	98	78	99
Leber et al (25)	Dual-Source CT	88	94	99	81	99
Ropers et al (26)	Dual-Source CT	100	92	97	68	99
Brodoefel et al (74)	Dual-Source CT	100	91	92	75	97

Note.—NPV = negative predictive value, PPV = positive predictive value.

Hachamovitch R.Circulation 2003;107:2900–7
Steel K. Circulation 2009;120:1390–400.
Bastarrika G. Radiology. 2009;253:317-38

Evaluation of cardiac structure and function



Taylor AJ. Circulation. 2010 Oct 25 (Nov 23, 2010)

Infarto de miocardio y viabilidad

- Estudios preliminares

Uptake of Contrast Materials by Experimental Acute Myocardial Infarctions: A Preliminary Report

CHARLES B. HIGGINS, MD,* MILOS SOVAK, MD, WALTER SCHMIDT, AND PAUL T. SIEMERS, MD

In Vivo Evaluation of Experimental Myocardial Infarcts by Ungated Computed Tomography

Computed Tomography for Localization and Sizing of Experimental Acute Myocardial Infarcts

WILLIAM R. GRAY, M.D., L. MAXIMILIAN BUJA, M.D., HERBERT K. HAGLER, PH.D., ROBERT W. PARKEY, M.D., AND JAMES T. WILLERSON, M.D.

Higgins CB. Invest Radiol. 1978;13:337-9
Huber DJ. AJR 1981;136:469–73
Gray WR. Circulation. 1978;58:497-504

Infarto de miocardio y viabilidad

Imaging

Characterization of Acute and Chronic Myocardial Infarcts by Multidetector Computed Tomography

Comparison With Contrast-Enhanced Magnetic Resonance

Bernhard L. Gerber, MD; Bénédicte Belge, MD; Gabin J. Legros, MD; Pascal Lim, MD; Alain Poncelet, MD; Agnès Pasquet, MD; Giovanna Gisellu, MS; Emmanuel Coche, MD; Jean-Louis J. Vanoverschelde, MD

ORIGINAL ARTICLE

A Feasibility Study of Contrast Enhancement of Acute Myocardial Infarction in Multislice Computed Tomography

Comparison With Magnetic Resonance Imaging and Gross Morphology in Pigs

Arno Buecker, MD, Marcus Katoh, MD, Gabriele A. Krombach, MD, Elmar Spuentrup, MD, Philipp Bruners, Rolf W. Günther, MD, Thoralf Niendorf, PhD, and Andreas H. Mahnken, MD

Imaging

Contrast-Enhanced Multidetector Computed Tomography Viability Imaging After Myocardial Infarction

Characterization of Myocyte Death, Microvascular Obstruction, and Chronic Scar

Albert C. Lardo, PhD; Marco A.S. Cordeiro, MD, PhD; Caterina Silva, MD; Luciano C. Amado, MD; Richard T. George, MD; Anastasios P. Saliaris, MD; Karl H. Schuleri, MD; Veronica R. Fernandes, MD; Menekhem Zviman, PhD; Saman Nazarian, MD; Henry R. Halperin, MD, MA; Katherine C. Wu, MD; Joshua M. Hare, MD; Joao A.C. Lima, MD

Comparison of multidetector CT with F-18-FDG-PET and SPECT in the assessment of myocardial viability in patients with myocardial infarction: A preliminary study

In Ho Lee [a], Yeon Hyeon Choe [a,*], Kyung Han Lee [b], Eun-Seok Jeon [c], Jin-Ho Choi [c]

[a] *Department of Radiology and Center for Imaging Science, Samsung Medical Center, Sungkyunkwan University School of Medicine, 50 Ilwon-dong, Gangnam-Gu, Seoul 135-710, Republic of Korea*
[b] *Department of Nuclear Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Republic of Korea*
[c] *Division of Cardiology, Department of Internal Medicine, and Cardiac and Vascular Center, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Republic of Korea*

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Assessment of Myocardial Viability in Reperfused Acute Myocardial Infarction Using 16-Slice Computed Tomography in Comparison to Magnetic Resonance Imaging

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Reperfused Myocardial Infarction: Contrast-enhanced 64-Section CT in Comparison to MR Imaging[1]

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Acute Myocardial Infarction: Contrast-enhanced Multi–Detector Row CT in a Porcine Model[1]

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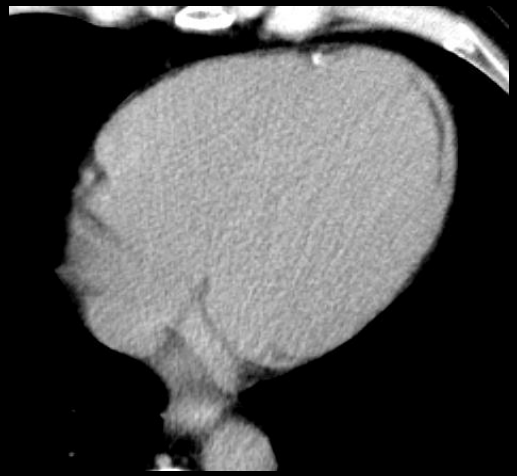
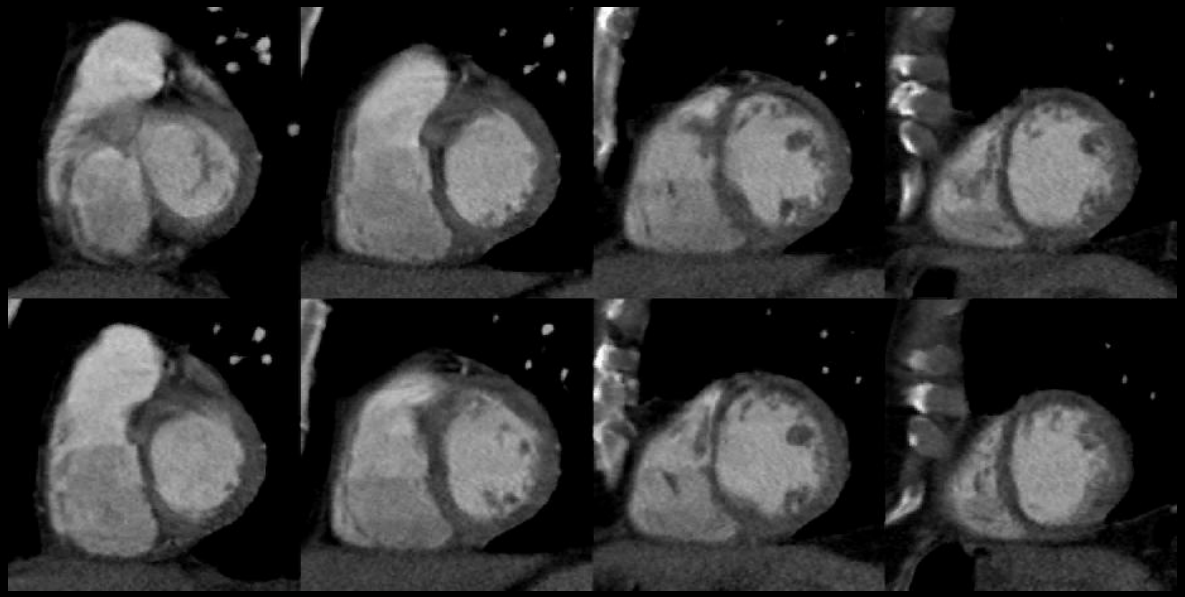
Características en TC del infarto de miocardio

- Adelgazamiento miocárdico
- Acúmulo de grasa en el subendocardico
- Más frecuentes en infartos más antiguos
  - Habitualmente en infartos del territorio de la DA
- Alteración de la función miocárdica
  - Anomalías de la contractilidad segmentaria
  - Disminución del engrosamiento sistólico del miocardio





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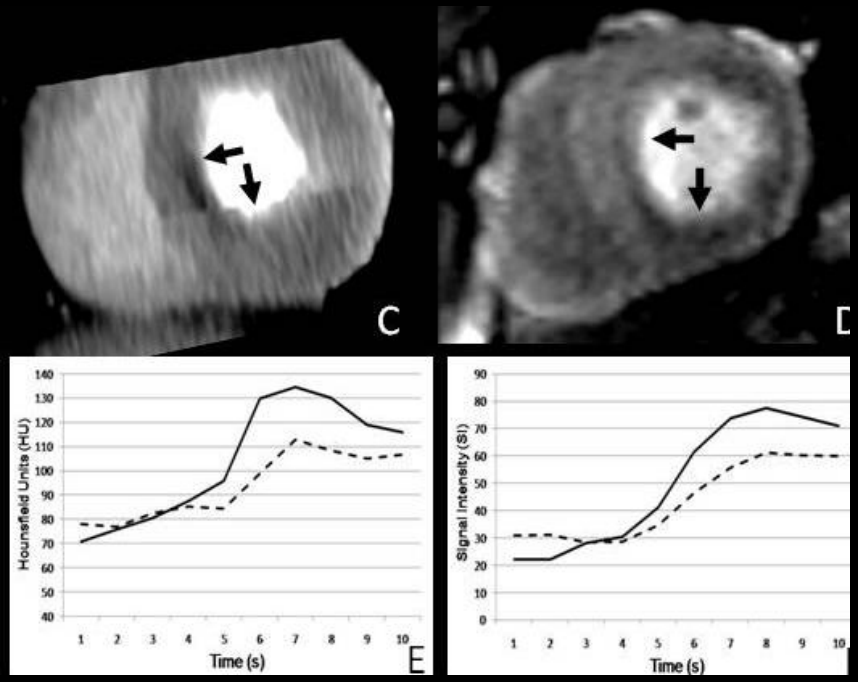
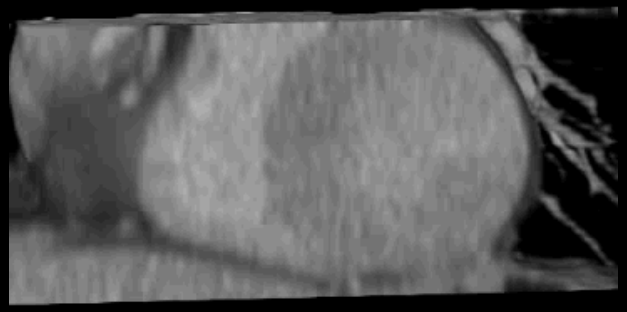
Contraste yodado y perfusión miocárdica

- El miocardio realza de forma homogénea tras la administración de contraste intravenoso
- Los agentes yodados empleados en TC cardiaco:
  - Poseen cinética similar al gadolinio empleado en CRM
  - Producen unos valores de atenuación (UH) en TC directamente proporcionales al contenido de yodo existente en el tejido
  - Esta relación es linear incluso por encima de las concentraciones requeridas para los estudios de perfusión miocárdica



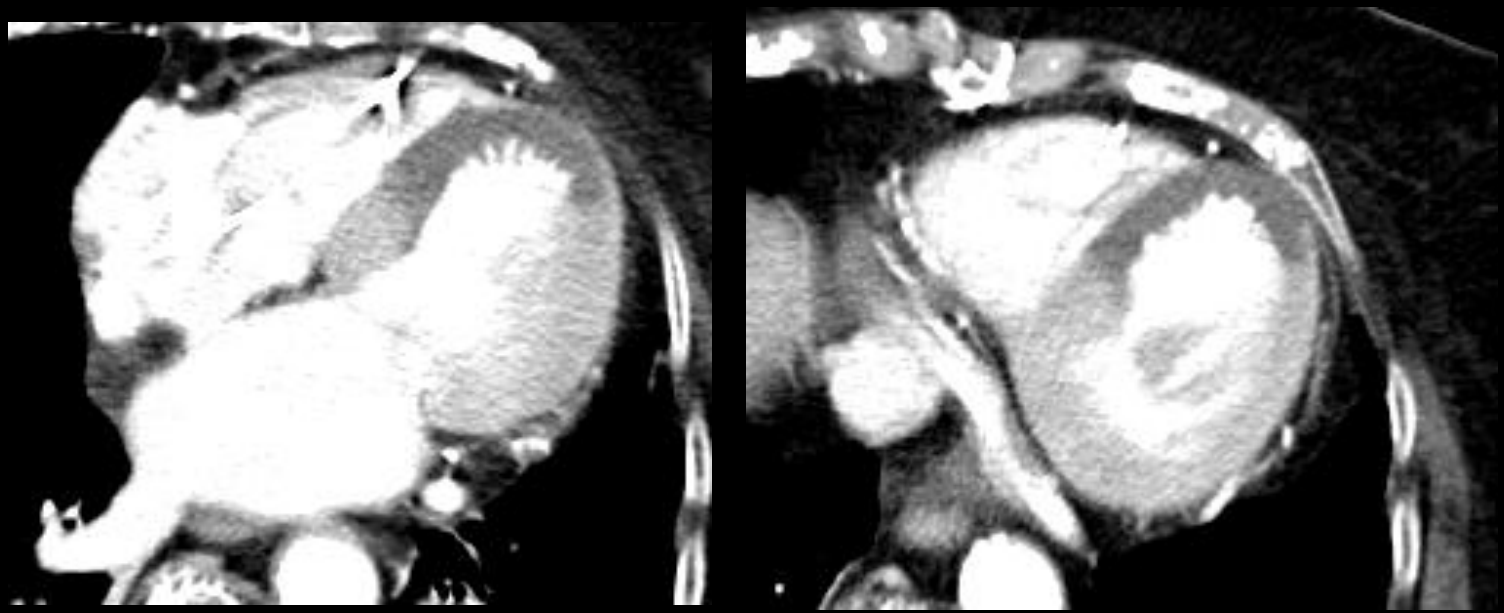


Gerber BL. Circulation 2006;113:823–33
Nieman K. Radiology 2008;247:49–56
George RT. Invest Radiol 2007;42:815–22

Contraste yodado y perfusión miocárdica

- El miocardio isquémico presenta una captación más tardía y una atenuación pico menor que el miocardio normal

- Hipoperfusión relativa en imágenes precoces tras administrar el contraste i.v.
  - Disminución de la densidad ≥20 UH



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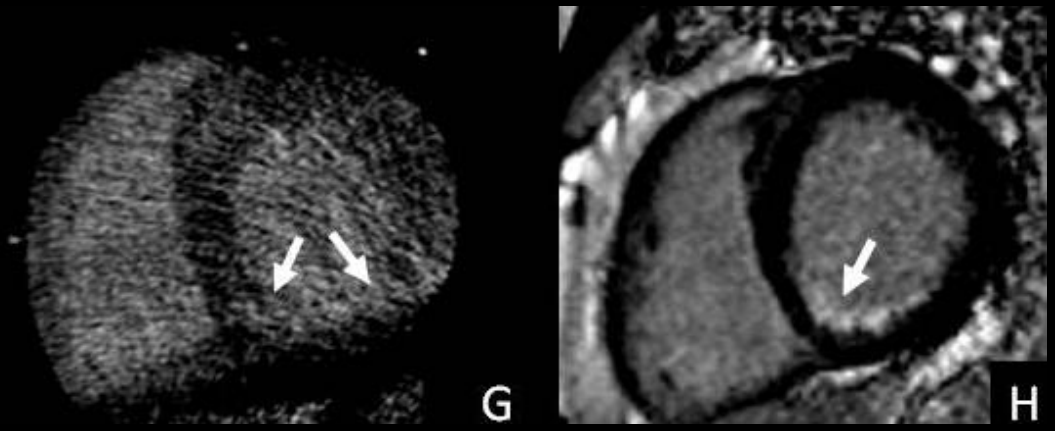
Contraste yodado y perfusión miocárdica

- Estudio de realce tardío (5–15 min tras contraste)
  - Similar a CRM
  - El realce es sugestivo de fibrosis miocárdica
  - Capacidad de distinguir entre miocardio viable y no viable

- El realce en fases tardía se observa en:
  - 94% de los casos de infarto agudo de miocardio
  - 100% de los casos de infarto crónico



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Nieman K. Radiology 2008;247:49–56
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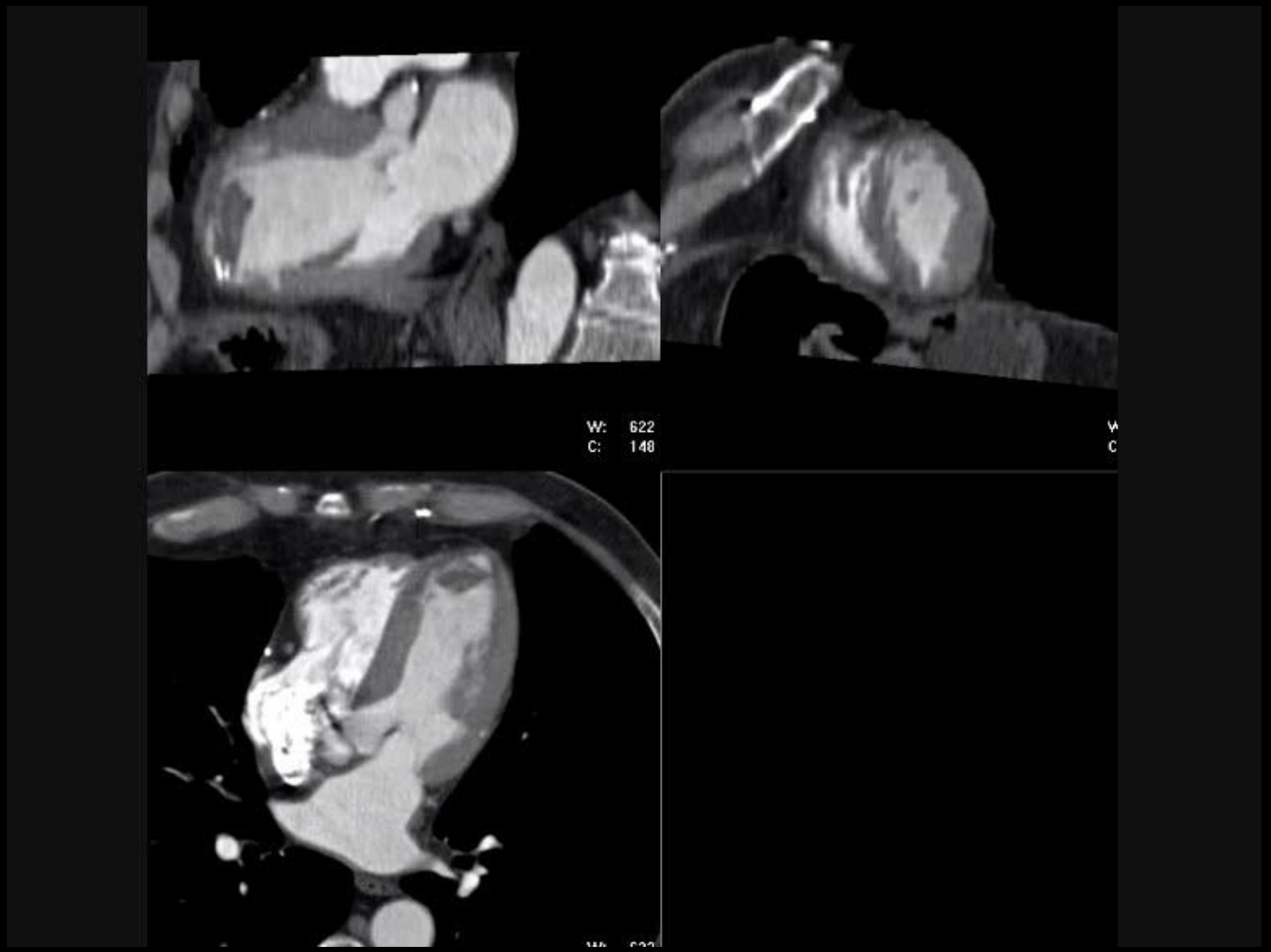
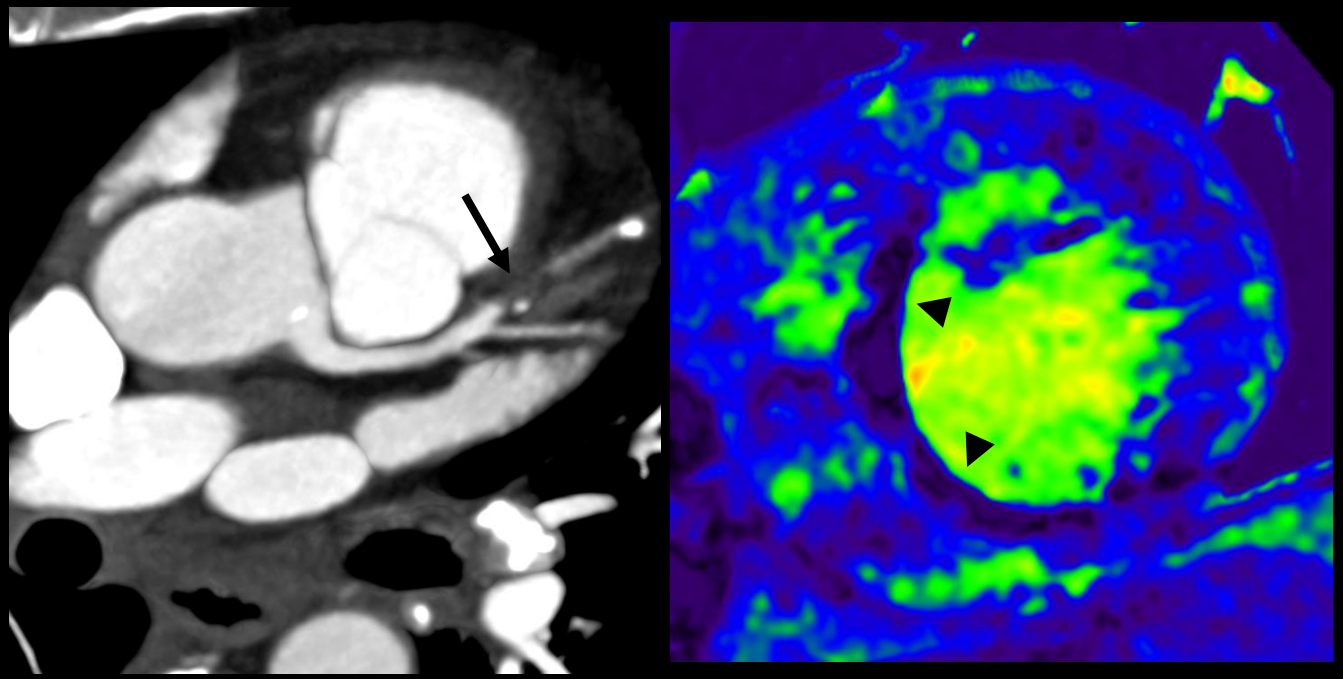
Características en TC del infarto de miocardio



Posibilidades de perfusión miocárdica con TCMC

- Perfusión en fases precoces (sin y con estrés farmacológico)
  - Similar a CRM y pruebas de medicina nuclear
  - Identifica áreas con disminución comparativa de la densidad (infarto/isquemia)



Gerber BL. Circulation 2006;113:823–33
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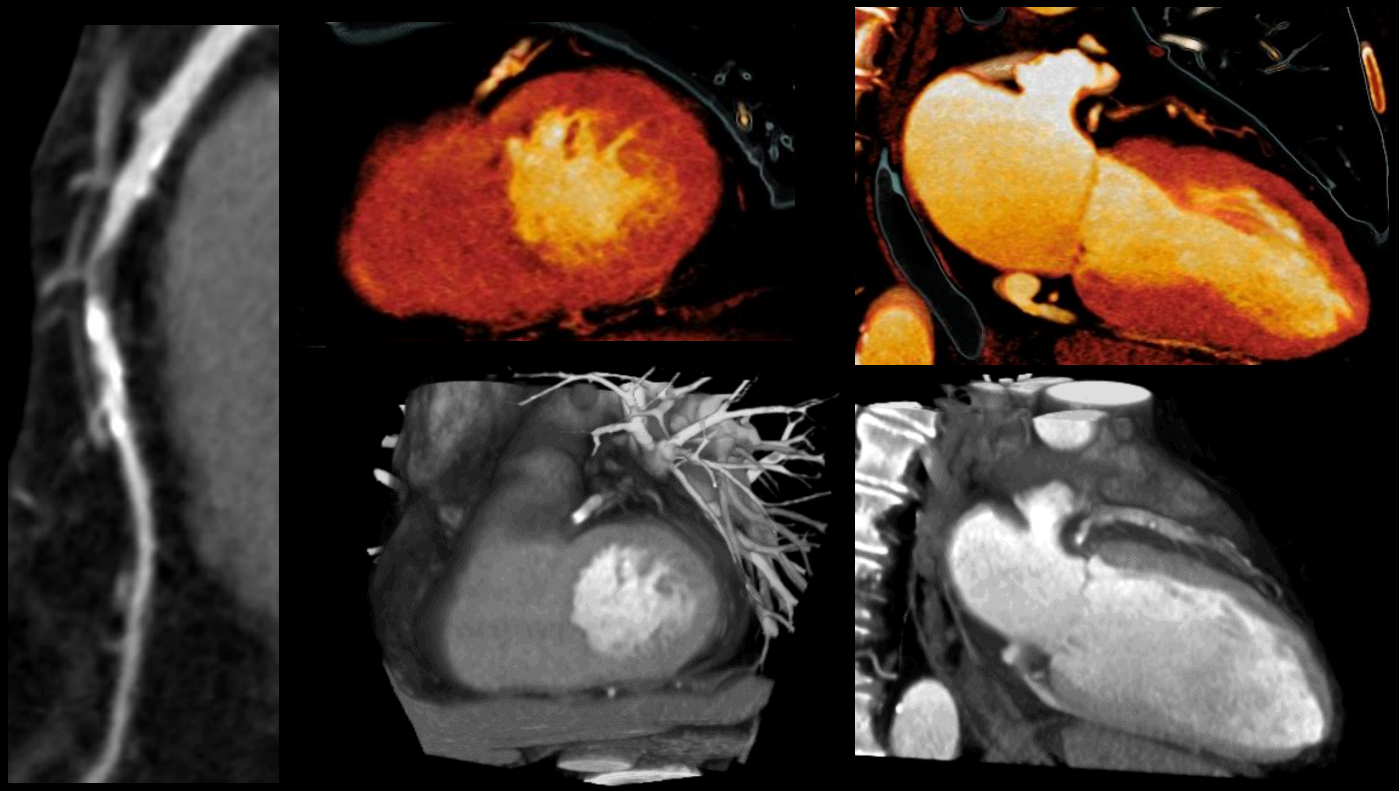
Posibilidades de perfusión miocárdica con TCMC

- Imagen estática, morfológica, en una única fase de perfusión:
  - Única fase del ciclo cardiaco
  - Importancia de cubrir todo el corazón durante la misma fase de opacificación del contraste



Gerber BL. Circulation 2006;113:823–33
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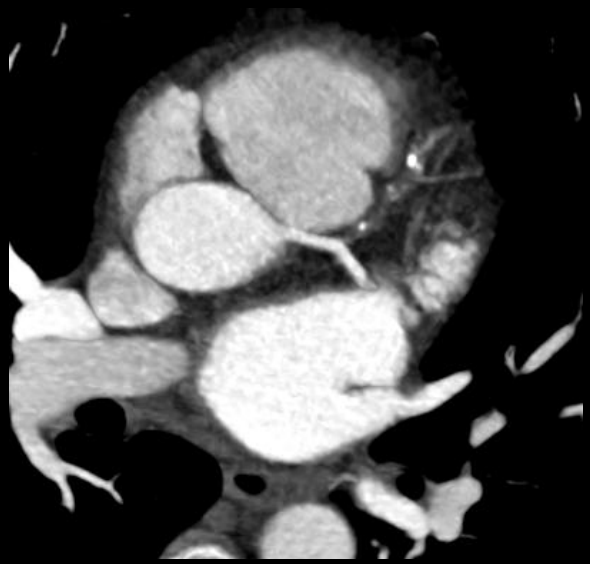
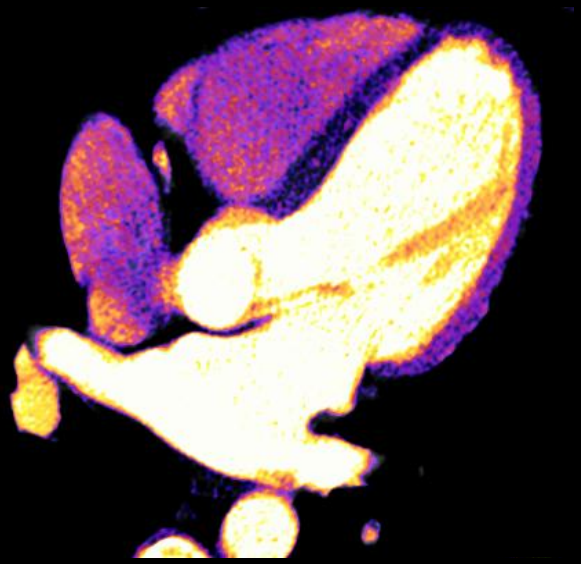
Características en TC de la isquemia miocárdica

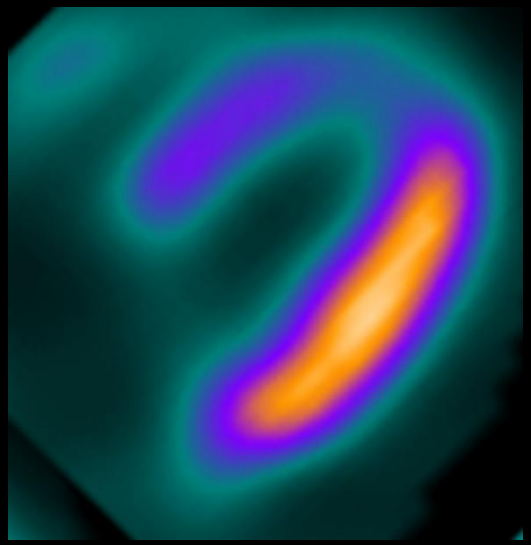
- La TC de doble energía perfusión-estrés farmacológico ha demostrado aportar una información similar al SPECT-estrés para detectar isquemia miocárdica:
  - Sensibilidades de 79% a 96%; especificidades de 73% a 92%
- En la misma exploración, además de la anatomía coronaria se pueden obtener imágenes de perfusión en reposo e imágenes de realce tardío



Coronary CTA



Stress DE-CT



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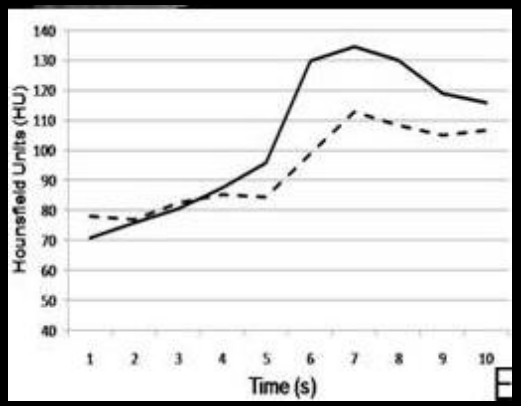
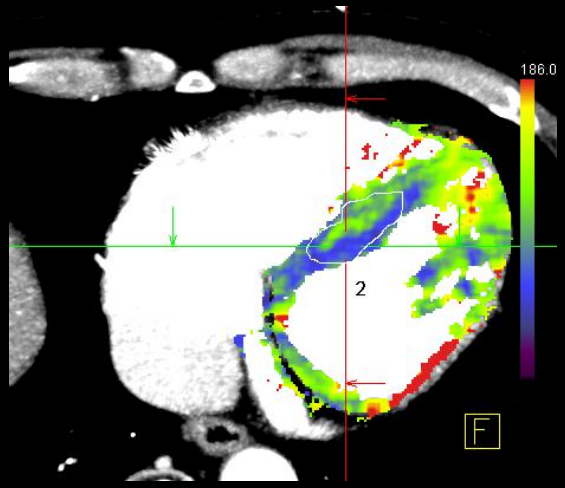
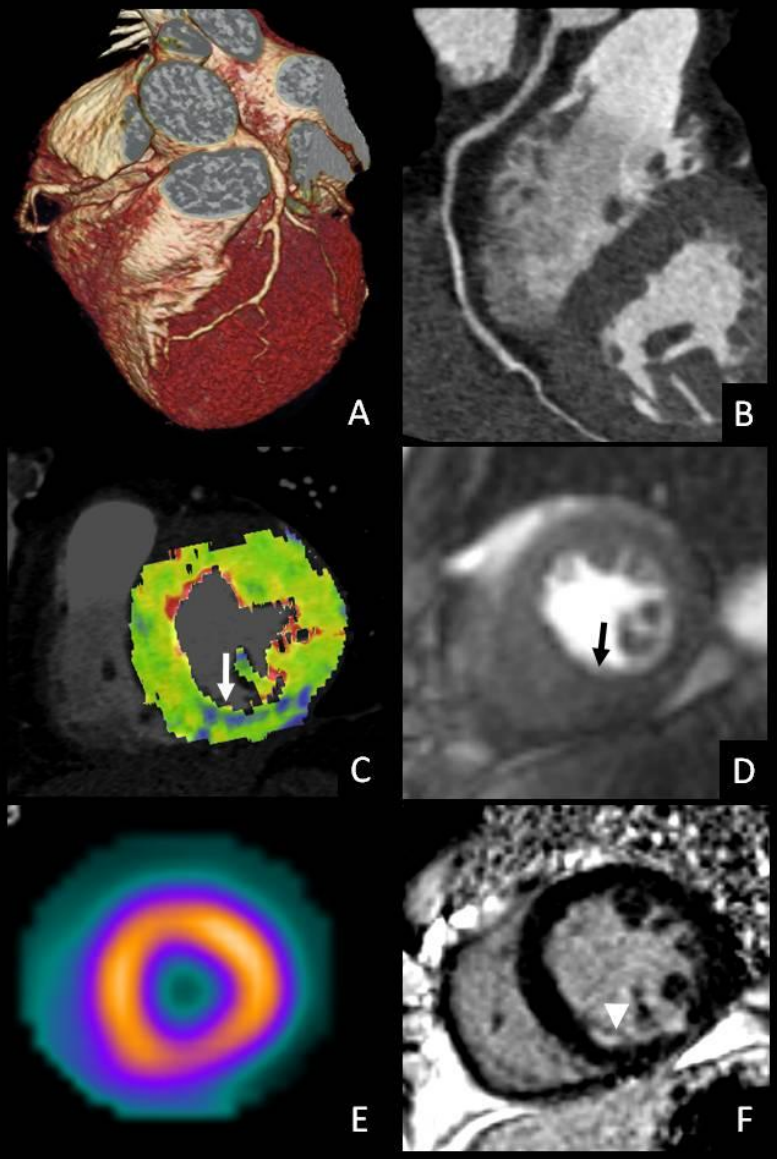
Direcciones futuras en la perfusión cardiaca

- Perfusión de primer paso
  - El miocardio isquémico muestra curvas de atenuación menores y más atenuadas que el miocardio normal
- Valoración cuantitativa del aporte sanguíneo al miocardio
- Estrategias para reducir la dosis de radiación
- Técnicas de doble energía
- Estudios que demuestren el valor pronóstico de la cardio-TC en la valoración de la cardiopatía isquémica





TC-perfusión cardiaca de primer paso de contraste



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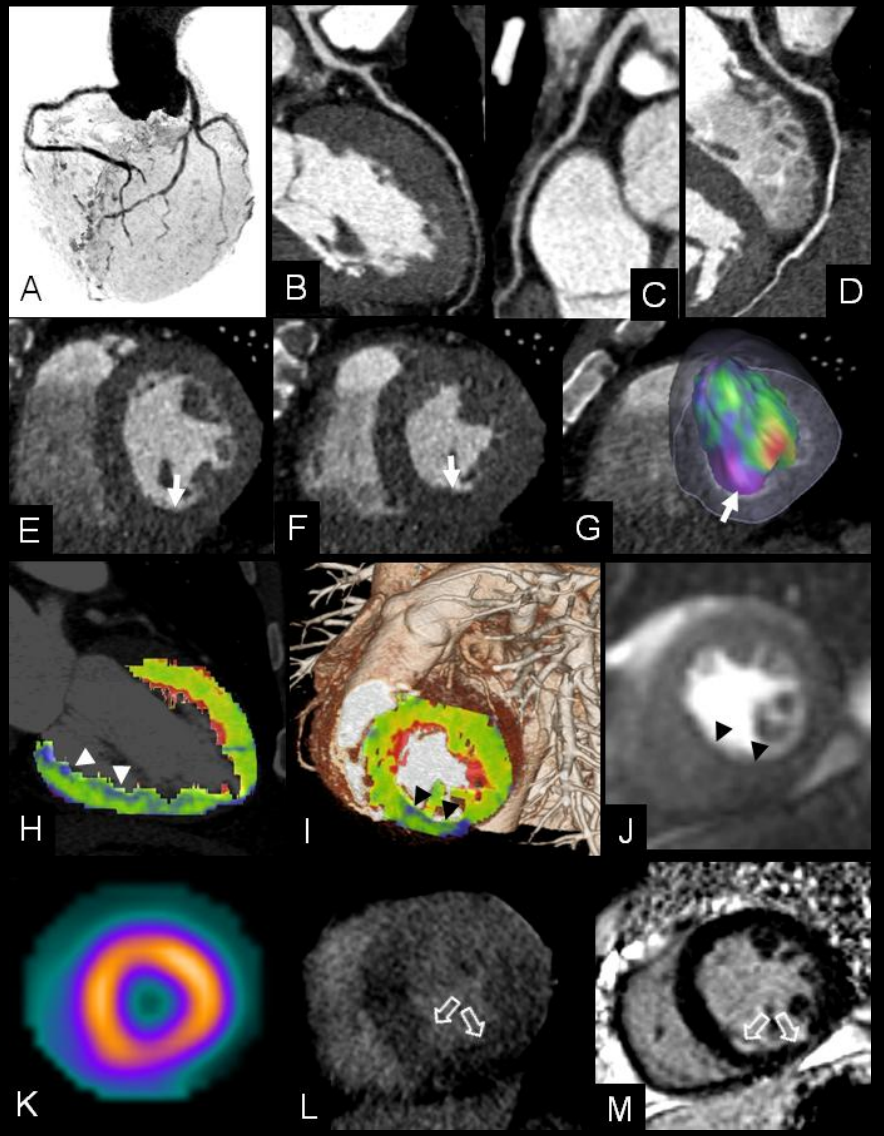
Mahnken AH. J Am Coll Cardiol 2005;45:2042–7

TC-perfusión cardiaca de primer paso de contraste

- Limitaciones:
  - Elevada dosis de radiación
  - Mayor cantidad de contraste
  - Artefactos (movimiento, endurecimiento del haz)



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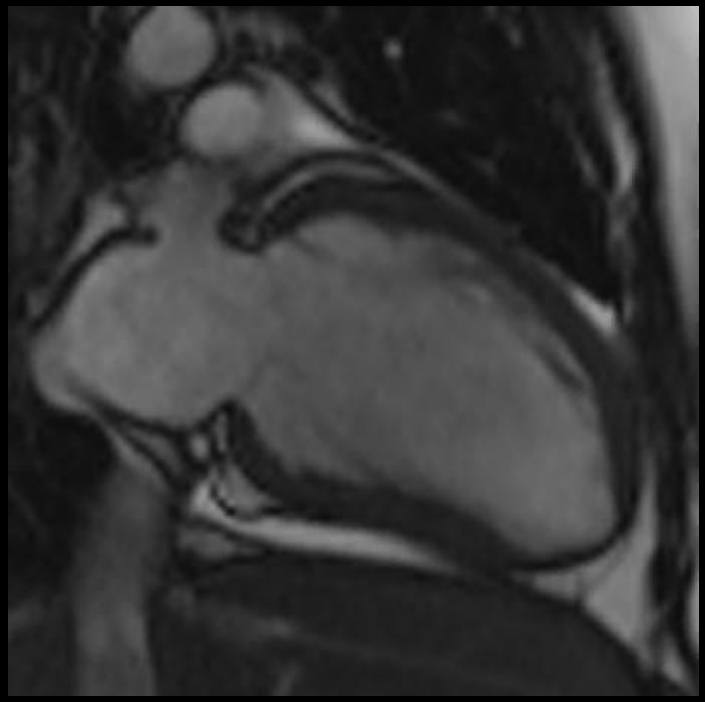
CRM en CI: Extensión y tamaño IAM y viabilidad

- Conceptos
- Protocolo de estudio
  - Infarto agudo
  - Infarto crónico
- Indicaciones CRM
- TCMC en cardiopatía isquémica



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