20 stems, 100 Questions, true or false for all questions:

1: Gadolinium (Gd): theory:

a: Unchelated Gd is toxic
b: has effects on T2 and T2* as well as T1
c: chelation (chemical binding) to DTPA has no effect on its in-vivo behaviour
d: chelation (chemical binding) to DTPA makes it safe
e: Magnevist, Omniscan, ProHance, OptiMARK and Dotarem are all Gd based.

2: Gd-DTPA: in-vivo use:

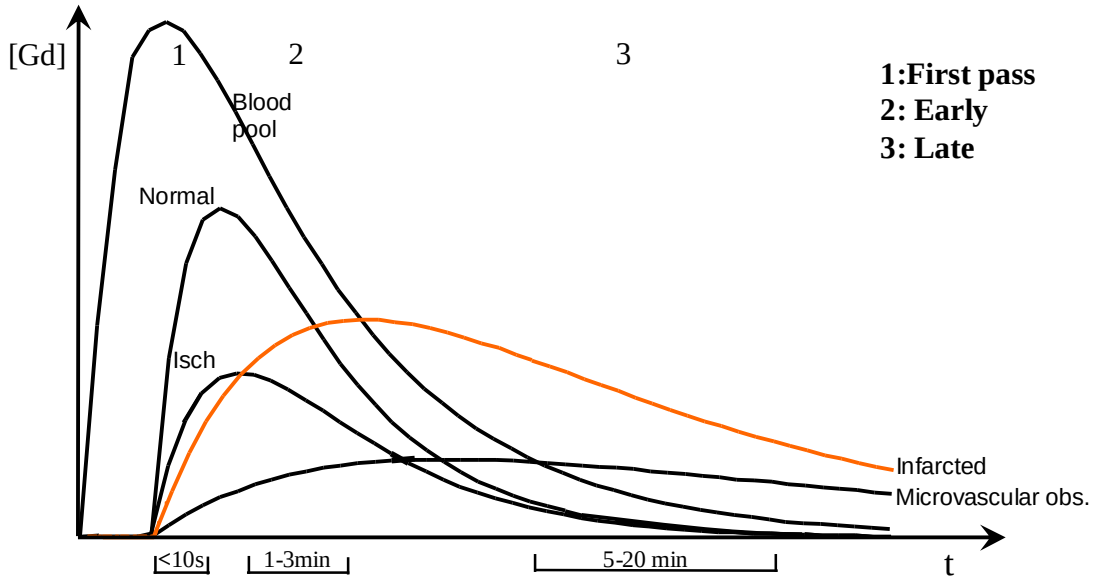
a: the most common side effect is nausea and headache
b: can cross the placenta and is best avoided in pregnancy
c: does not requires resuscitation equipment to be available during its use
d: High dose use in renal failure has/had an FDA warning 22/12/2006
e: should be injected into a large vein for late gadolinium imaging.

3: Gd-DTPA tissue distribution: In infarction:

a: acute and chronic MI have less extracellular fluid than normal myocardium
b: wash-in/wash-out myocardial kinetics are slower in infarcted myocardium
c: DTPA determines in-vivo behaviour, the Gd making the DTPA visible by MR
d: microvascular obstruction causes no reflow at angiography
e: a first pass perfusion defect can be cause by microvascular obstruction

4: In the graph below of gadolinium kinetics after an i.v. bolus:

a: myocardial perfusion is measured during the first pass
b: in the early phase, microvascular obstruction has very little gadolinium
c: viability imaging is performed when infarcts have less Gd than normal tissue
d: Gd-DTPA binds to infarcted tissue, so it remains longer in infarcted tissue
e: if imaging is left too late, then the differences between tissues becomes less



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5: Inversion-recovery: In this T_1 recovery graph in 3 tissues after a pre-pulse:

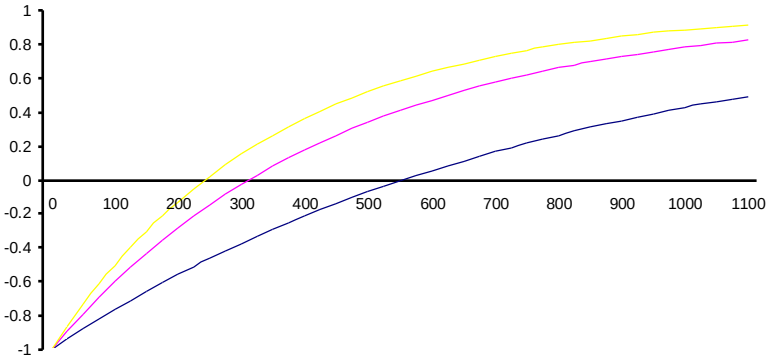
a: IR imaging is extremely sensitive and high contrast, but needs careful adjustment to be successful

b: the T_1 of the blue (lower) line is about 550ms

c: The yellow (top) line could be tissue with the most gadolinium in it

d: The T_1 of any of the tissues represented is the x axis crossing point.

e: If imaging occurs at 300ms, the yellow and blue line tissues will appear bright



6: Practical IR imaging: nulling:

a: The TI is chosen to null the infarct

b: If the TI is too long, normal myocardium will become grey and badly nulled

c: If the TI is too short, normal myocardium will become grey and badly nulled

d: After a bolus of Gd-DTPA, the required TI decreases with time

e: The required TI is always shorter than the actual TI and heart rate dependent.

7: Image quality: adjustment of the TI. In the images below:

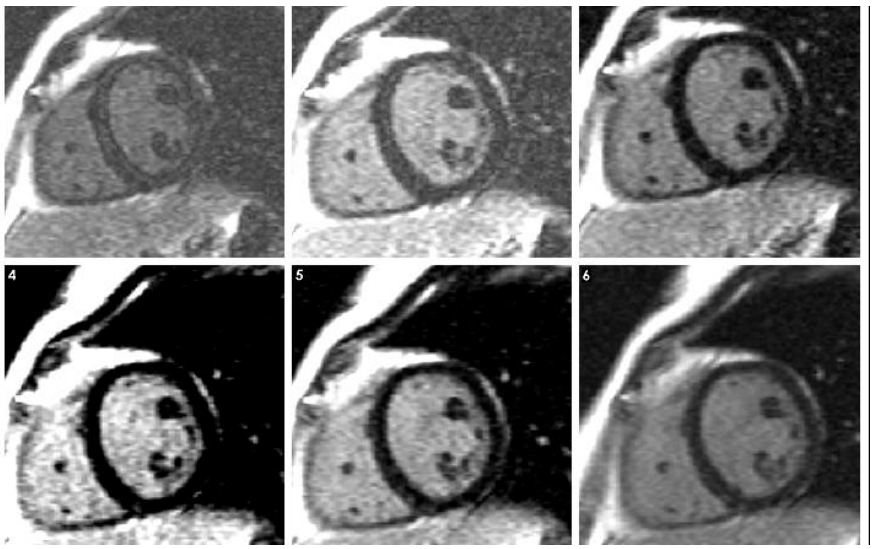
a: The TI is too short in 1 and needs increasing

b: If the TI is too long, phase cancellation (endocardial dark line) occurs as in 1

c: The TI is too long in 6 and needs reducing

d: The images do not rule out a global infiltrative disease

e: Waiting and repeating the scan with the same TI will improve image 6



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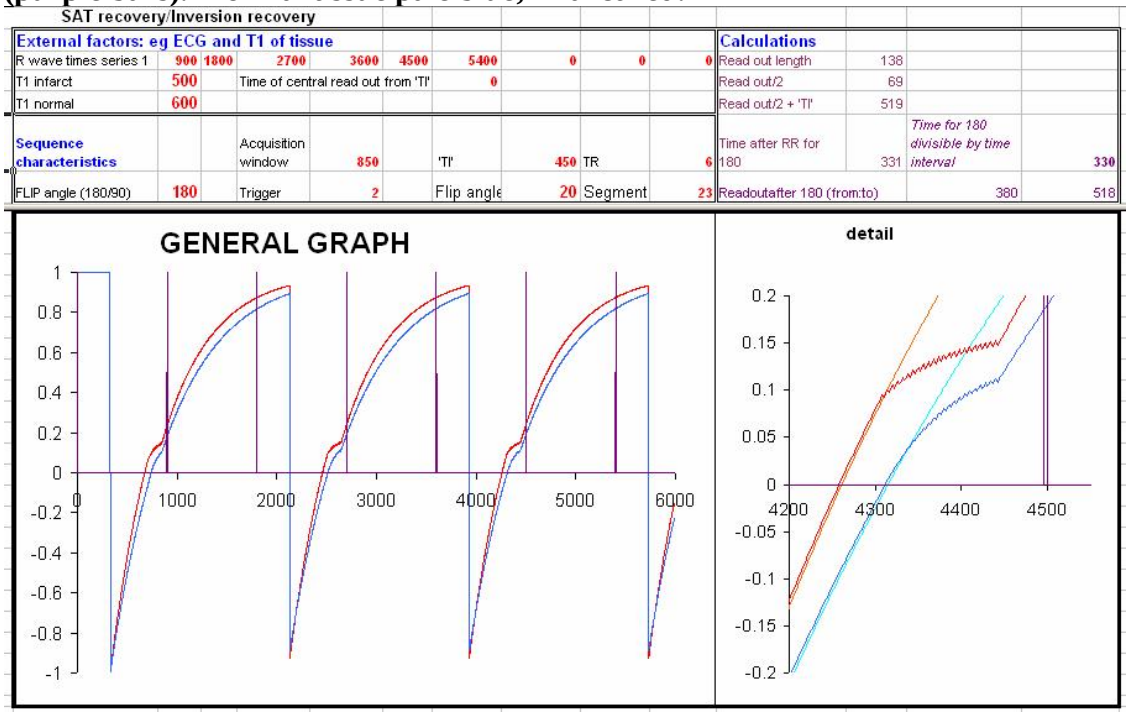
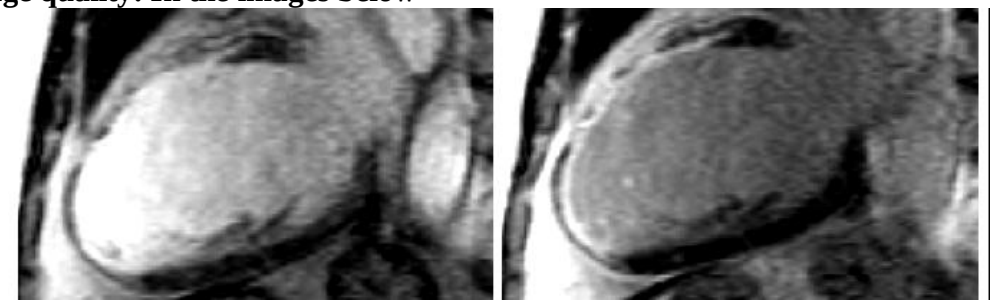
8: The graph below represents the longitudinal magnetisation during an IR sequence for late gd: (x axis, time (ms); y axis Mz). There is an R wave every 900ms (purple bars). Normal tissue pale blue; infarct red.



a: The time between the first 180 and normal tissue crossing the x axis is the true TI, equivalent to T1/ln(2)
b: The time between the second 180 and normal tissue crossing the y axis is less than the true TI – as are all subsequent cycles.
c: For a 115 phase encoding steps with this segmentation (23), alternate heart beaks, this acquisition will take (115/23)x2 heart beats, = 10 heart beats
d: The read-out is affecting longitudinal recovery.
e: Look at the 'detail' graph between 4200ms and 4500ms. The TI programmed is too long – remote myocardium will be grey rather than black.

9: Image quality: In the images below



a: image quality is better on the left
b: the blood is too bright in 1 to see subendocardial infarction
c: the resolution has been increased on the right
d: image 2 is a later repeat of image 1
e: the nulling is about the same in 1 and 2, but the TI will have been longer in 2

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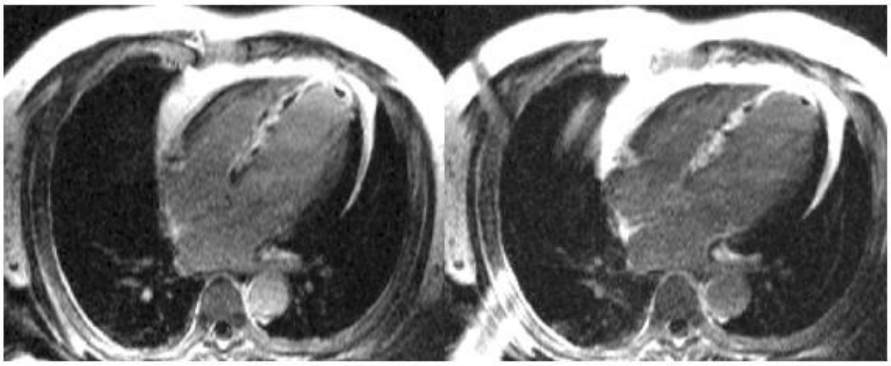
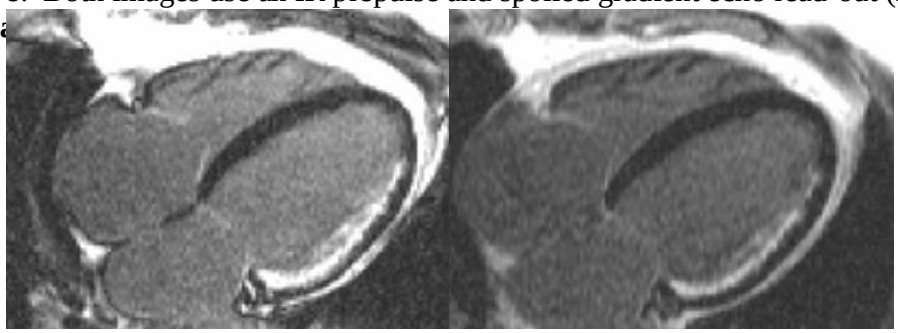
10. Imaging techniques: In the images below



a: LGE reproducibility in the 4 ch view is very sensitive breath-hold changes
b: The image on the right could in theory have taken 3 minutes to acquire
c: The islands of preserved subendocardial viability may reflect reperfusion
d: If this is an infarct, it is likely to have occurred within the last month
e: Both images use an IR prepulse and spoiled gradient echo read-out (FLASH)

11: Ima



a: the bright area is dead myocardium
b: there is a partial thickness infarct present
c: the image on the left is IR-SSFP, the one on the right IR-FLASH
d: IR-SSFP can be used instead of IR-FLASH for infarct imaging
e: IR-SSFP does not require the same meticulous adjustment of the TI

12: Newer IR sequences and future techniques

a: 3D sequences have longer read-outs than equivalent single slice imaging – but at no cost to nulling.
b: LGE images are acquired near the nullpoint so are low SNR - parallel imaging should not affect this.
c: Standard IR-FLASH imaging ignores phase information – but you could use phase information to make choice of TI less important
d: By nulling remote myocardium, you lose almost all information on the nulled interstitium and will miss diffuse interstitial expansion.
e: Current CMR technology is insufficient to reliably distinguish normal and infracted tissue using intrinsic contrast alone – so extrinsic contrast is used.

13. Bolus of gadolinium: double dose or single dose? (0.1mmol or 0.2mmol?)

a: if the higher dose is used, the delay before late imaging must be longer
b: if the higher dose is used, the TIs required will be longer
c: double dose will be less heart rate sensitive
d: 0.1mmol, 0.125mmol and 0.2mmol have all been used in humans.
e: doing late Gd imaging properly is more important than the dose used

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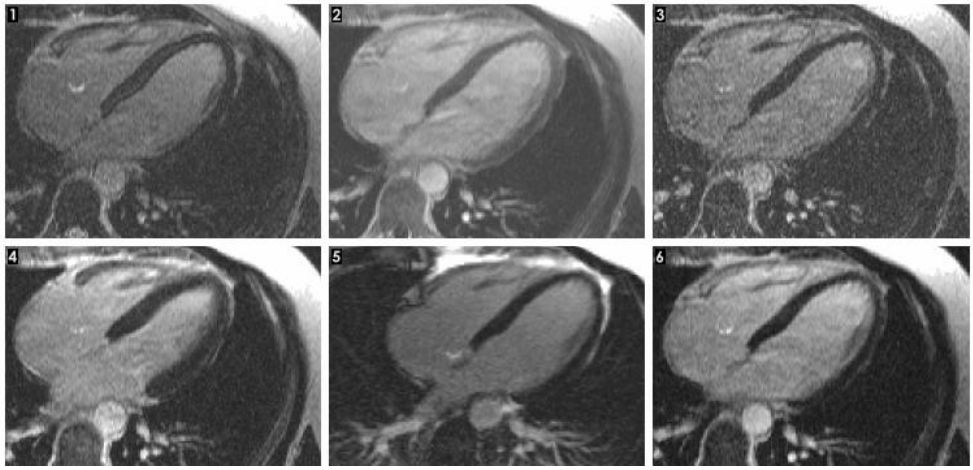
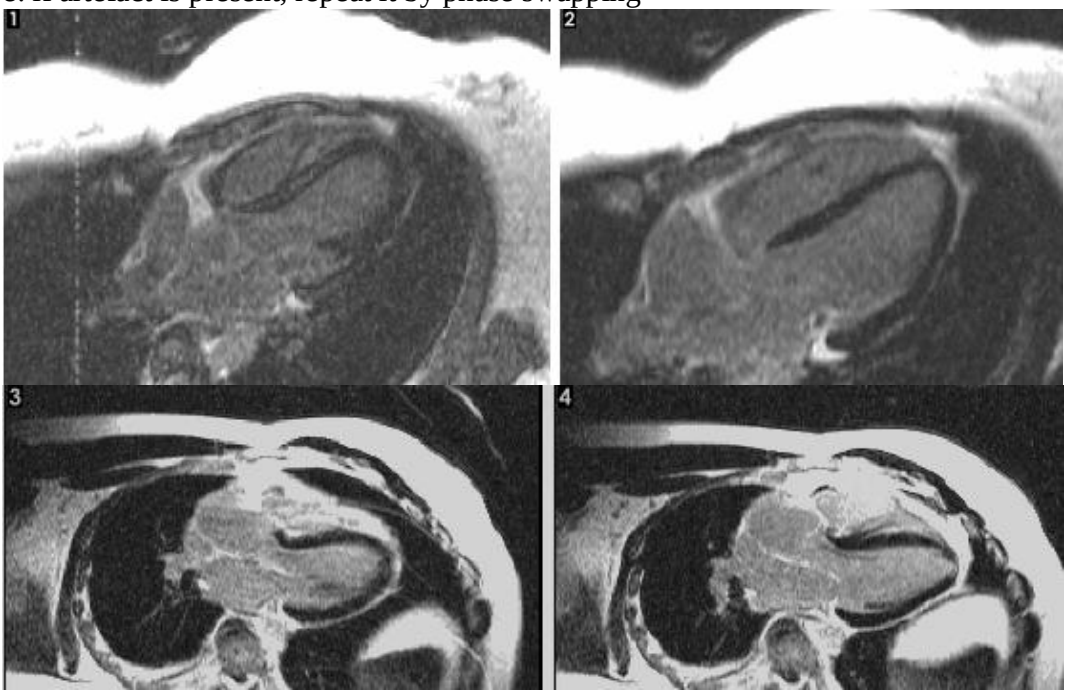
14. Artefact: In the images below

a: The TI is too short in image 1
b: The TI is too short in image 2
c: image 3 is grainy: increasing the slice thickness or FOV would help
d: image 4 is diastolic
e: there is CSF ghosting; placing a presaturation band over the CSF will remove it



15. Artefacts: in the images below

a: rf noise in 1 could be due to the scanner room door being open
b: there is mid myocardial enhancement in image 1
c: the TI was shortened for image 2 after image 1
d: to obtain image 4, 3 was repeated after talking to the patient to wake him up
e: if artefact is present, repeat it by phase swapping



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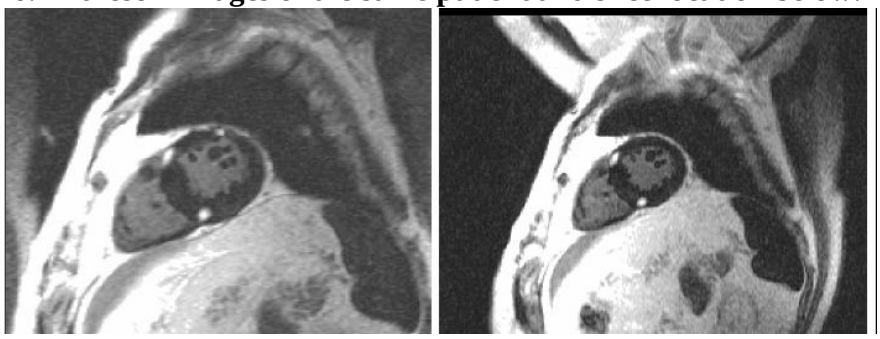
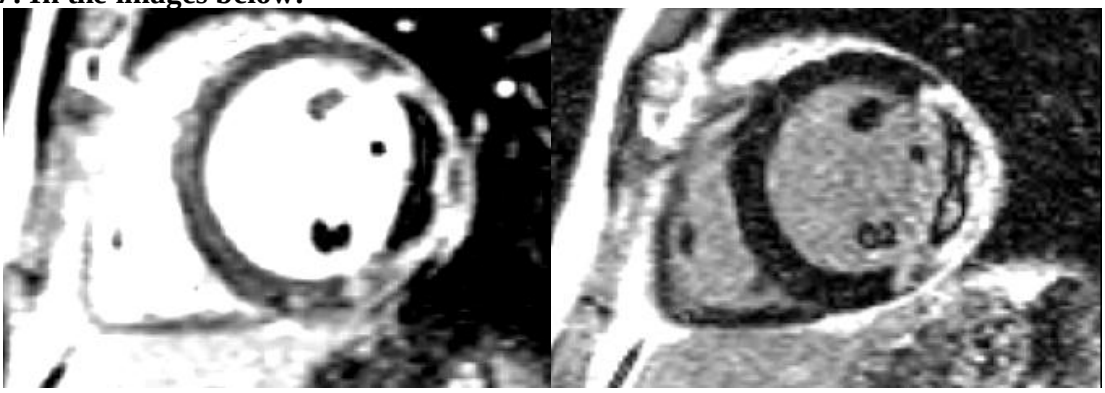
16. In these 2 images of the same patient and slice location below:



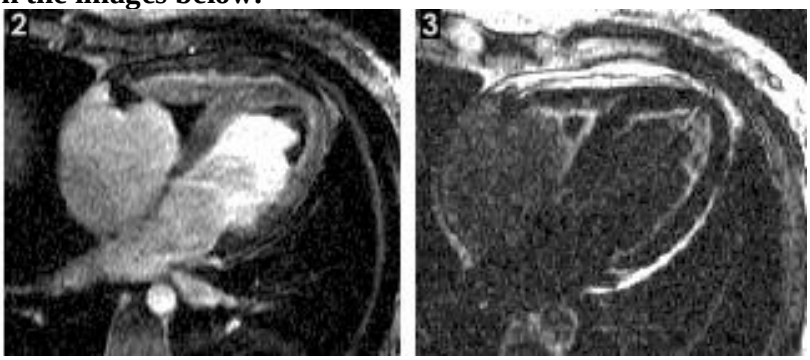
a: the image (L) has AP phase encoding and head-foot (R)
b: there are 3 focal areas of enhancement
c: this enhancement is unlikely to be related to coronary artery disease
d: an oblique through the areas of enhancement would help
e: enhancement here represents dead myocardium (white is dead)

17: In the images below:



a: the image on the left is for MVO and was performed early with a very long TI
b: normal myocardium is nulled in the early image
c: after the MVO imaging, late gd was performed with shorter TIs
d: this infarct is not transmural
e: Regions of MVO have a bright core with black surround during late gd imaging

18. In the images below:



a: in the early imaging, left, avascular thrombus is deliberately nulled
b: there is biventricular apical thrombus
c: there is extensive subendocardial enhancement
d: Late gadolinium imaging can be used in non-ischaemic heart disease
e: this pattern is typical of ischaemic heart disease

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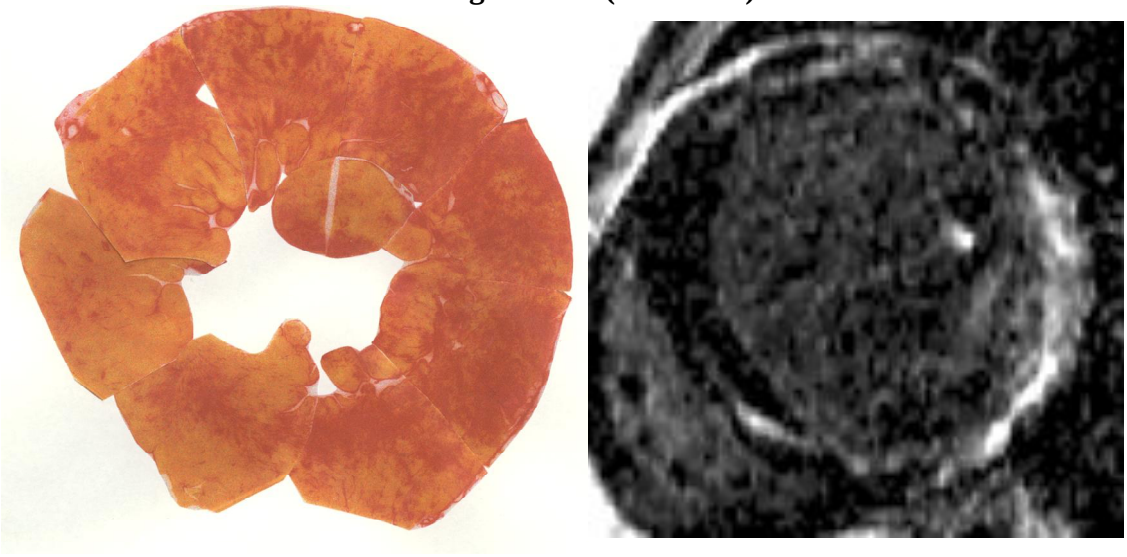
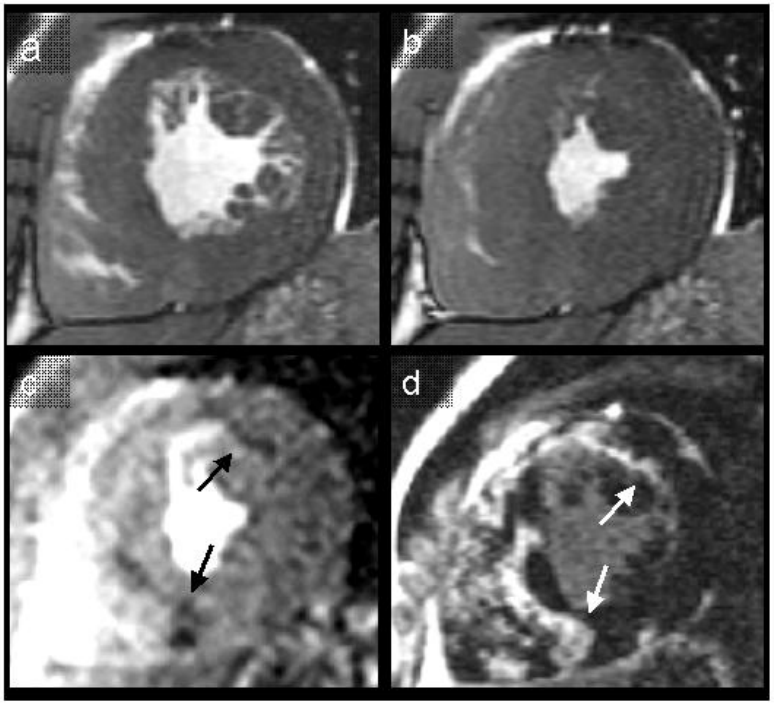
19. In this ex-vivo short axis histological slice (Sirius red) and in-vivo LGE:



a: red represents collagen
b: post mortem cardiac tissue contracts down to a supra-systolic state
c: This pattern of fibrosis is rare in ischaemic heart disease
d: areas of Sirius red ex-vivo appear to enhance in-vivo
e: 'white is dead' applies to this case

20. In the case below of glycogen storage disease type 3 (cine diastole 1, systole 2, rest perfusion 3 and LGE 4)



a: The pattern of LGE is not consistent with an ischaemic aetiology
b: The pattern of LGE is not consistent with epicardial coronary artery disease
c: Some of the LGE is associated with rest perfusion defects
d: There is RV involvement
e: An intracellular storage disease seems to be causing extracellular pathology

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