Late Gadolinium imaging – Quiz answers
SCMR 2007

James Moon
Based on original Quiz Produced at the Department of CMR
Royal Brompton Hospital; Modified whilst at The Heart Hospital, London

This presentation posted for members of scmr as an educational guide – it represents the views and practices of the author, and not necessarily those of SCMR.

The Heart Hospital, University College London James@moonmail.co.uk

Gadolinium and theory of contrast

- First described 1984
- Gd→T_1↓, but effects on T2 and T2* as well
- Free gadolinium is toxic
- Chelated to DTPA or similar:
  - Makes it non-toxic
  - Determines the distribution and kinetics:
  - Gd-DTPA an extracellular (extravascular) agent
- Several different forms available commercially

Question 1: a T b T c F d T e T

Gd-DTPA in-vivo use

- Safer than iodine based X-ray contrast
  - Most common side effect: nausea and vomiting
  - Rarely, more serious side effects
  - resuscitation equipment and trained staff needed
  - See FDA public health advisory 22/12/2006 on high dose Gd-DTPA for MRA in renal failure.
  - (this presentation 4/2/2007 – so check for latest news)
  - http://www.fda.gov/cder/drug/advisory/gadolinium_agents.htm
- Crosses the placenta
- Eliminated mainly via the kidneys
- Perfusion/angiography needs rapid bolus via large vein; late gadolinium: any iv is fine

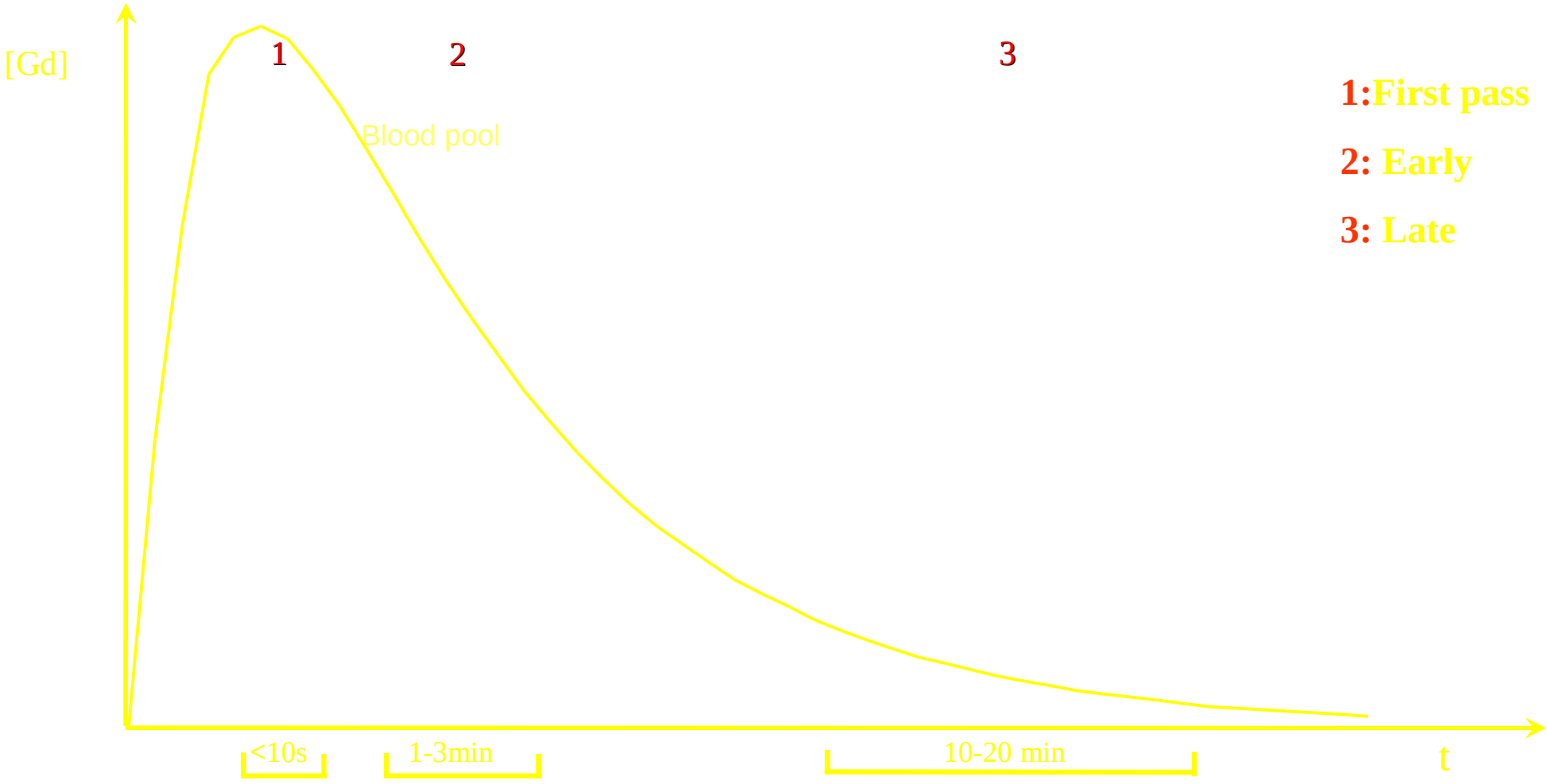
Question 2: a T b T c F d F e F

Gd-DTPA in-vivo use

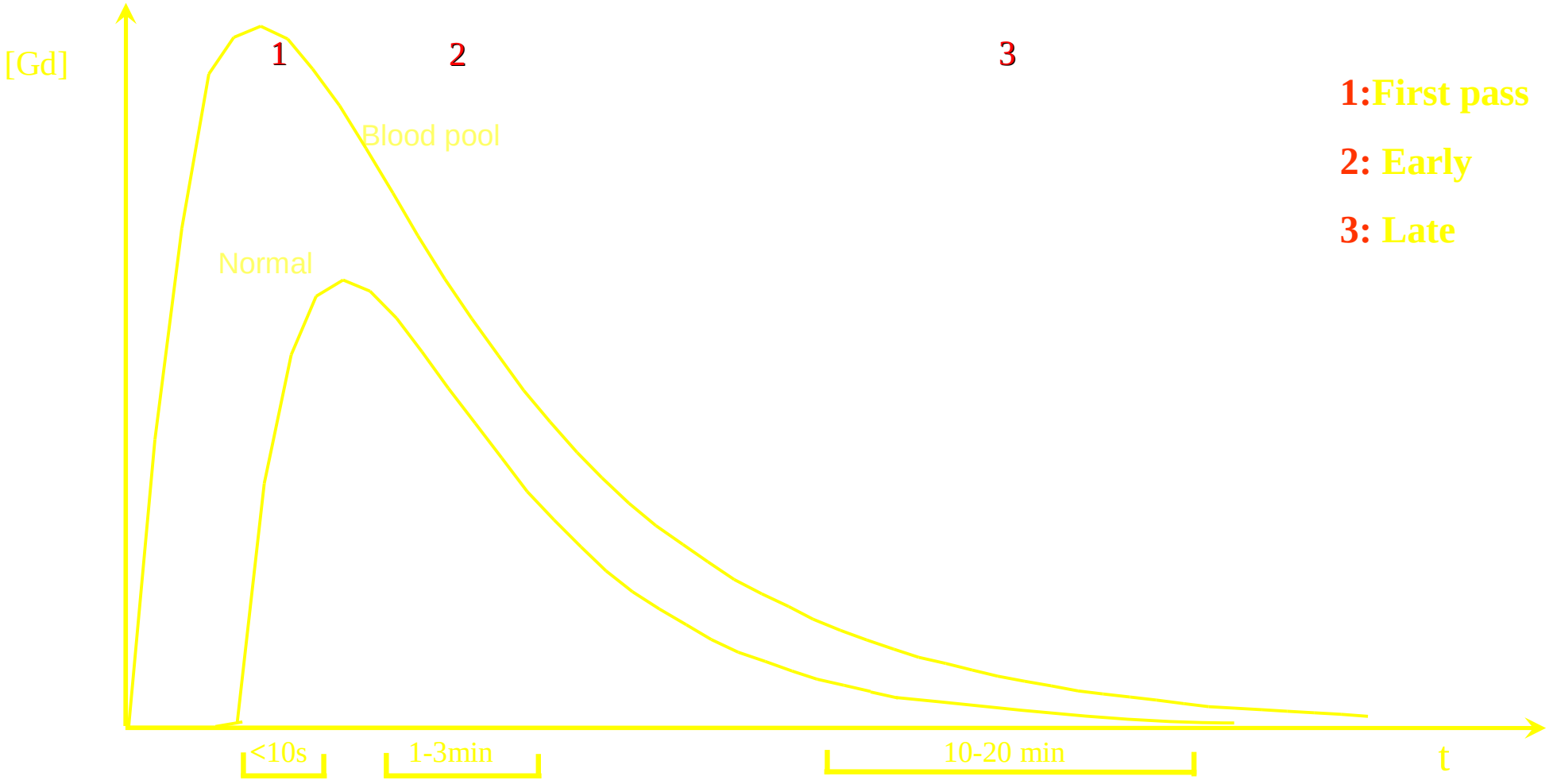
- Different behavior in normal and infarcted tissue
  - Different kinetics
  - Different distribution
- Kinetics: wash-in and wash-out phases
  - fast normal (1-2min); slow infarcted (up to 30min)
  - normal follows blood pool; infarct lags
- Total volume of distribution
  - Extracellular only, cannot enter cells
  - Fibrosis/oedema: more extracellular fluid, more Gd

Question 3: a F b T c T…….

Kinetics of gadolinium: 3 time periods



Kinetics of gadolinium: 3 time periods

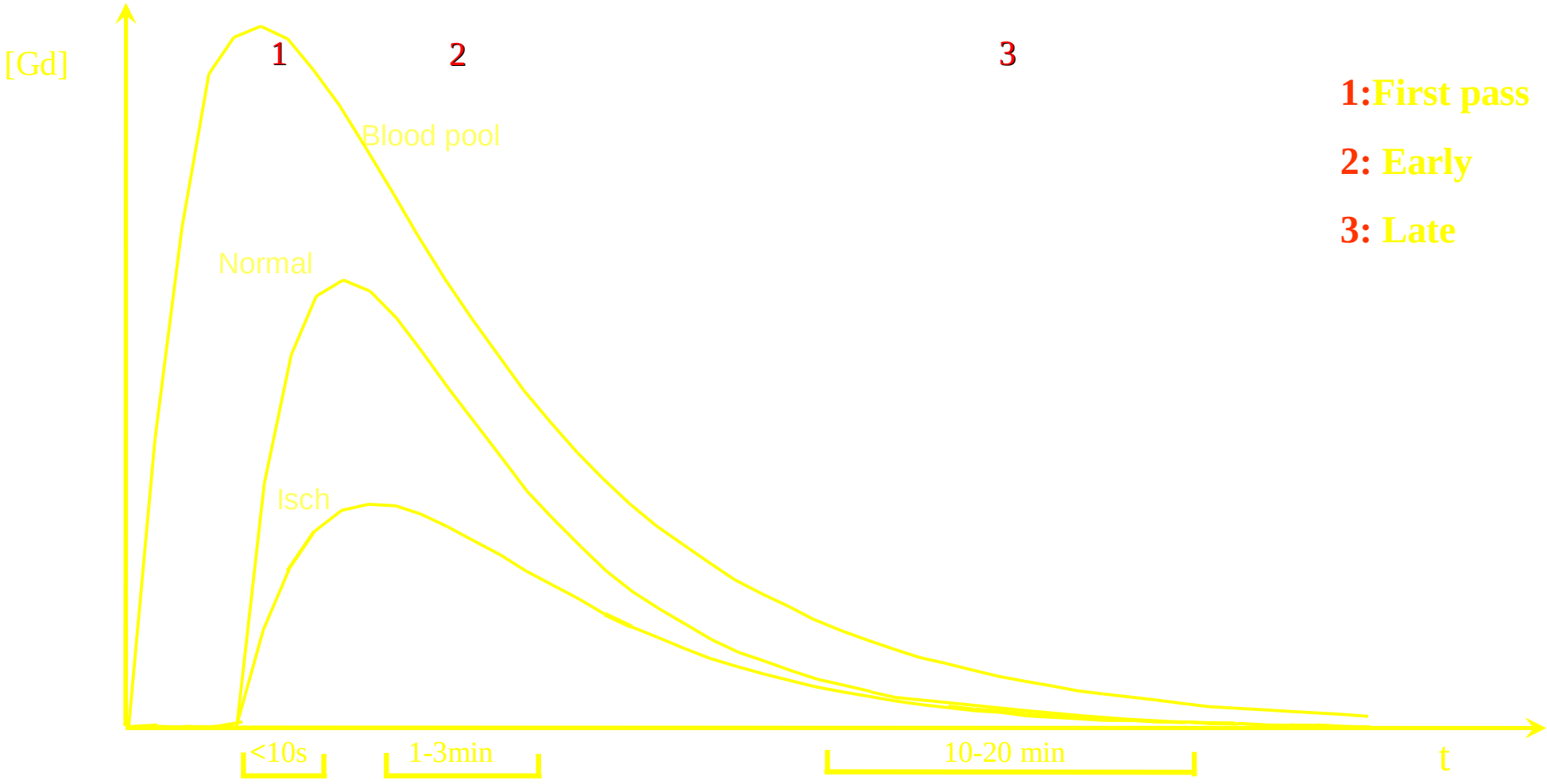


1:First pass

2: Early

3: Late

Kinetics of gadolinium: 3 time periods

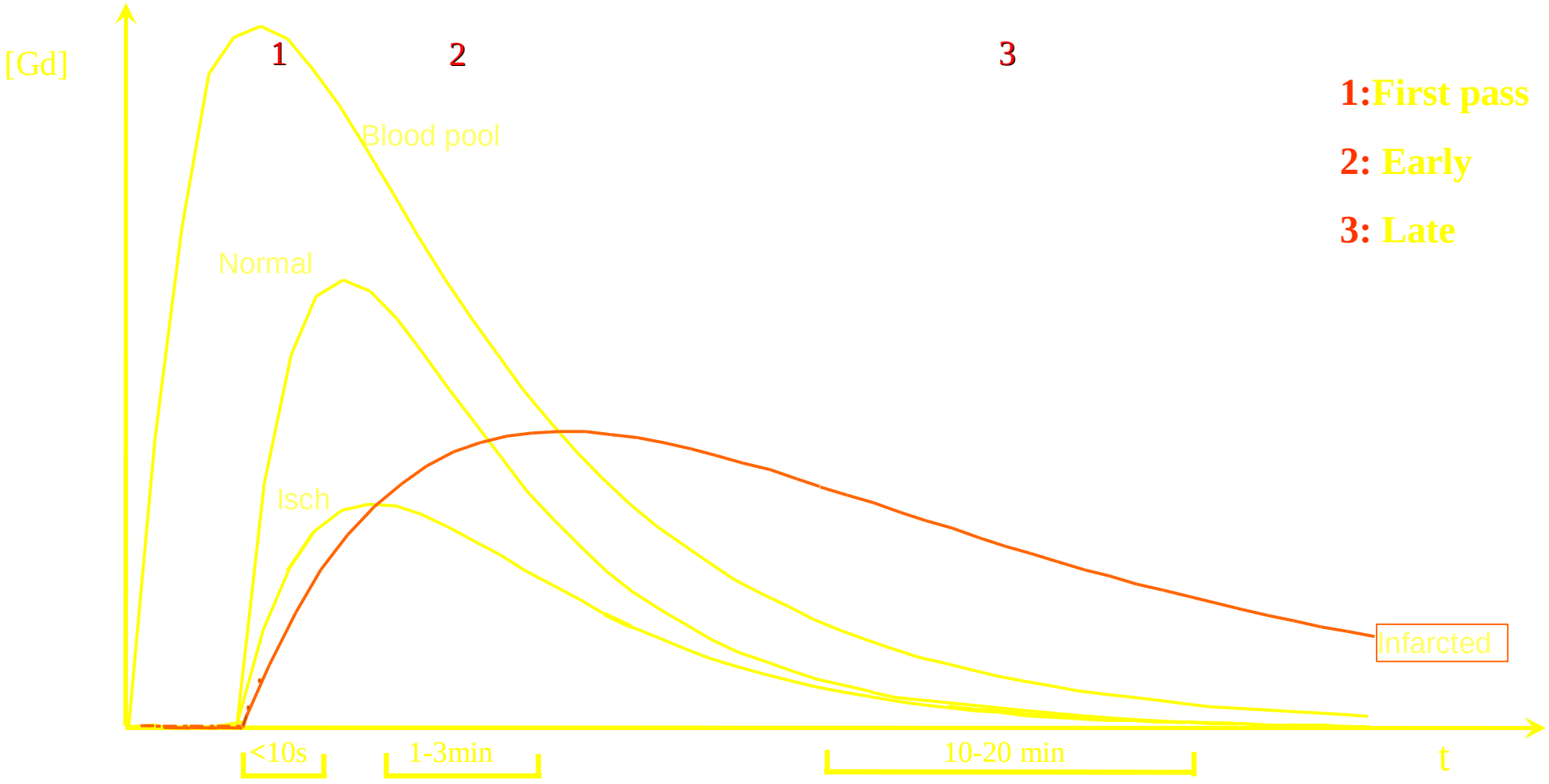


1:First pass

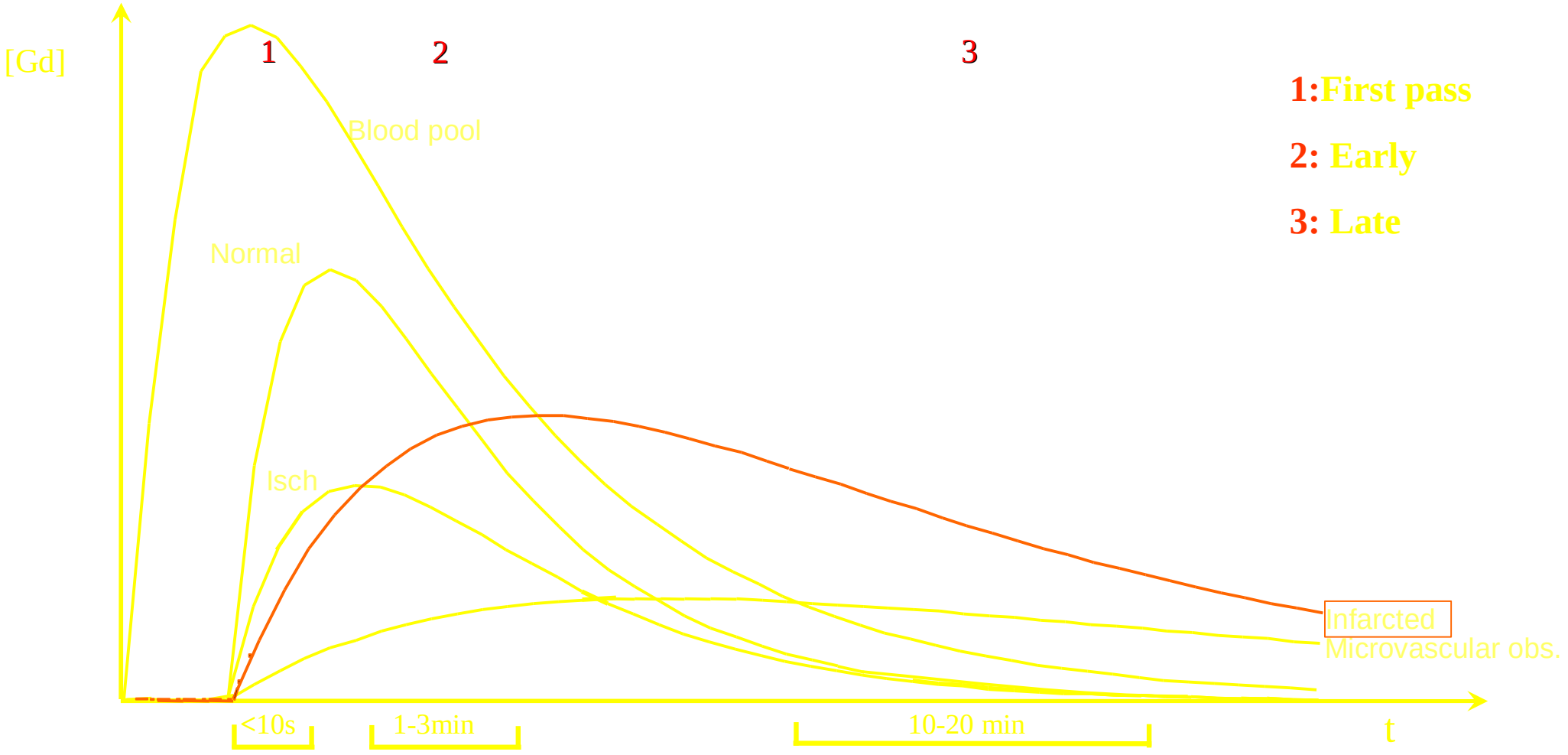
2: Early

3: Late

Kinetics of gadolinium: 3 time periods



Kinetics of gadolinium: 3 time periods



1:First pass

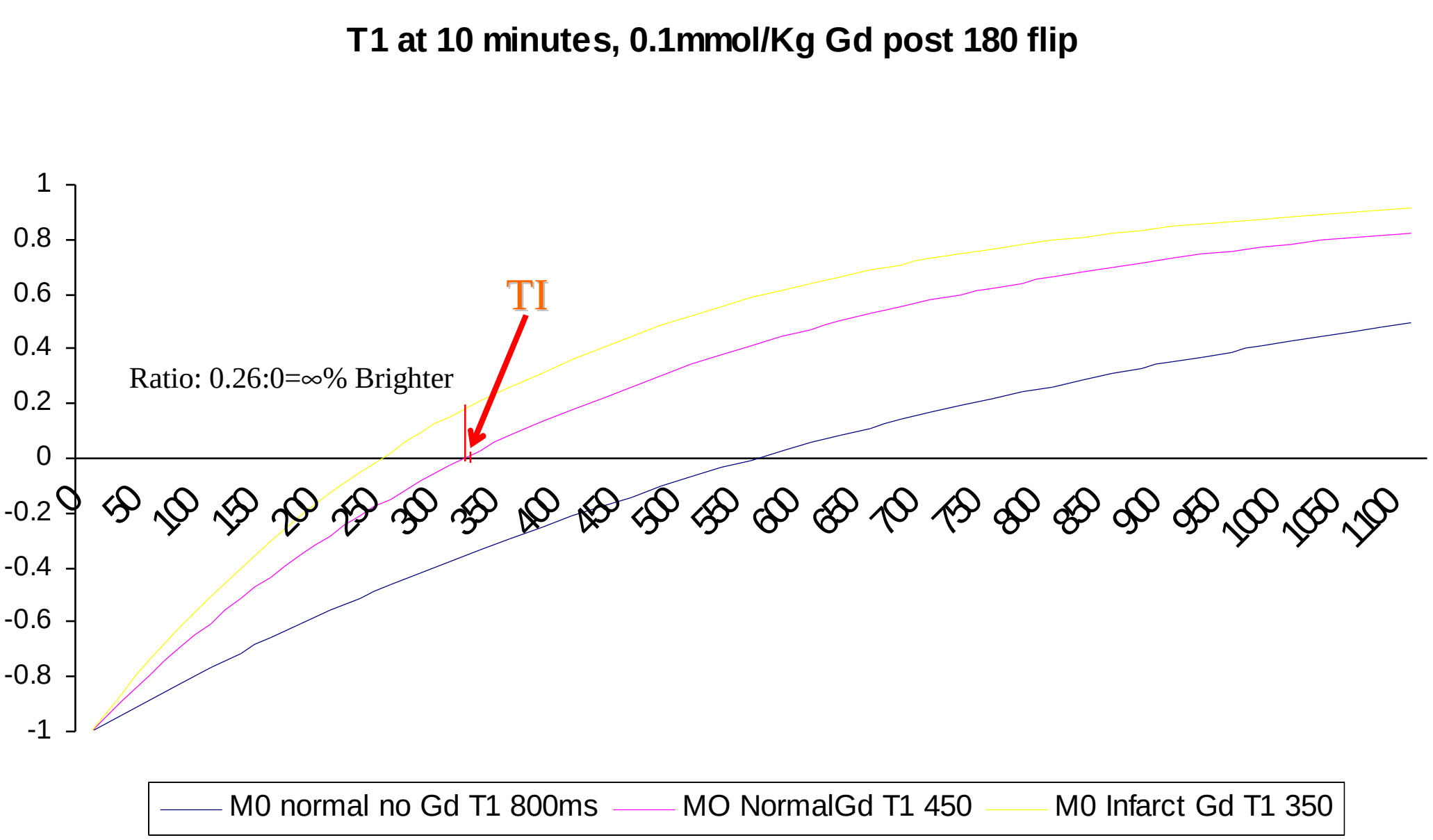
2: Early

3: Late

Question 3 d T e T 4: a T b T c F d F e T

Inversion Recovery - IR

- Gd-DTPA can be seen with any sequence
  - TSE, STIR, FLASH, TrueFISP
- Best is to use Inversion Recovery
  - Nulls one tissue (Image intensification)
  - Nulled tissue: DARK
  - All other tissue: BRIGHT
- High Sensitivity
  - At expense of absolute quantification
  - Sequence takes a little looking after



Question 5: a T b F c T d F e T

Gd-DTPA in-vivo use

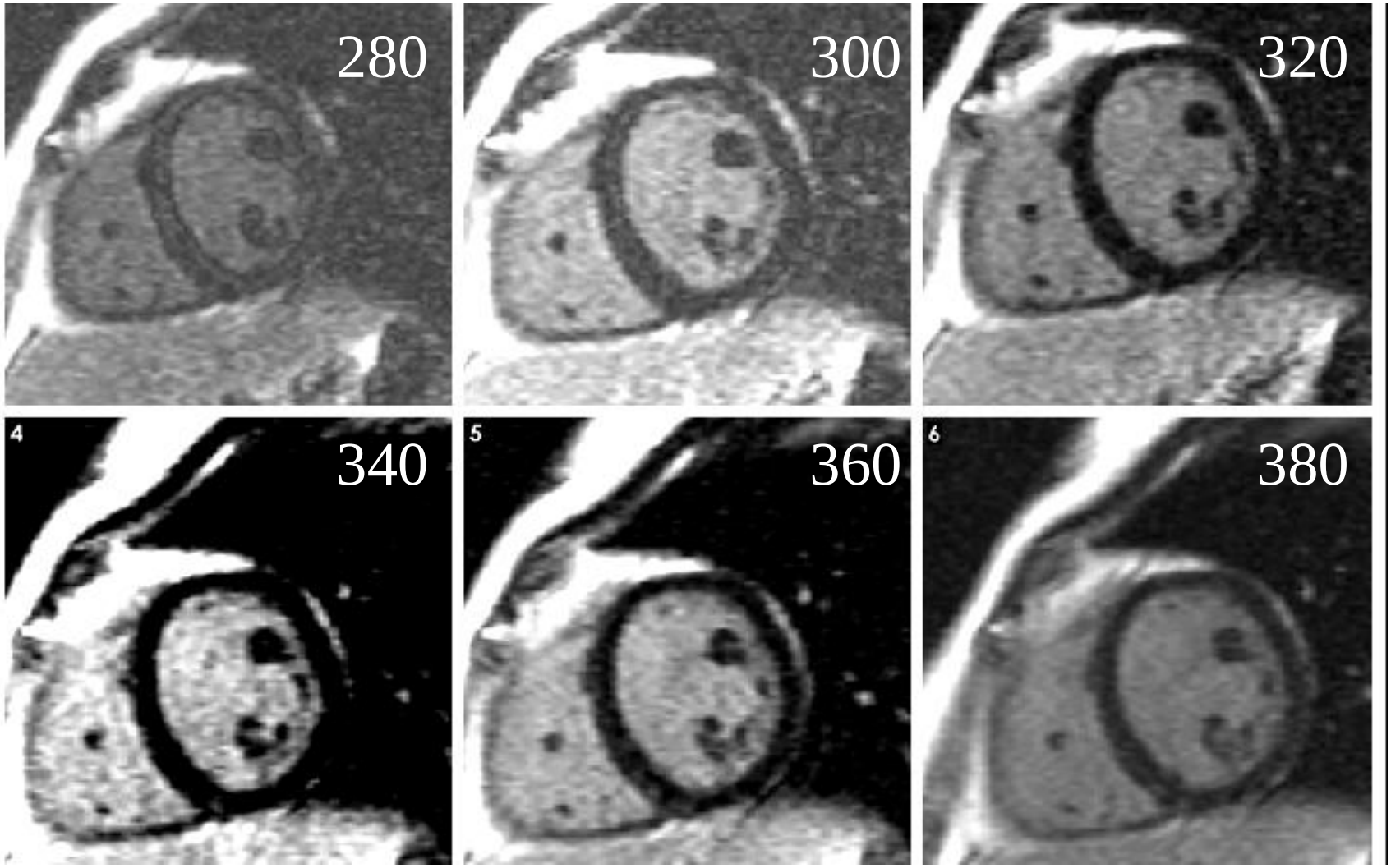
- Choose TI to null the infarct
  - Get it too long: normal myo becomes gray
  - Get it too short: normal myo becomes gray
- Too short a TI – black phase cancellation lines
- As Gd-DTPA washes out:
  - TI needed gets longer
- Because of Imaging before full T_1 recovery
  - TI needed always shorter than the true TI

Question 6: a F b T c T d F e T

scan, review, adjust, rescan

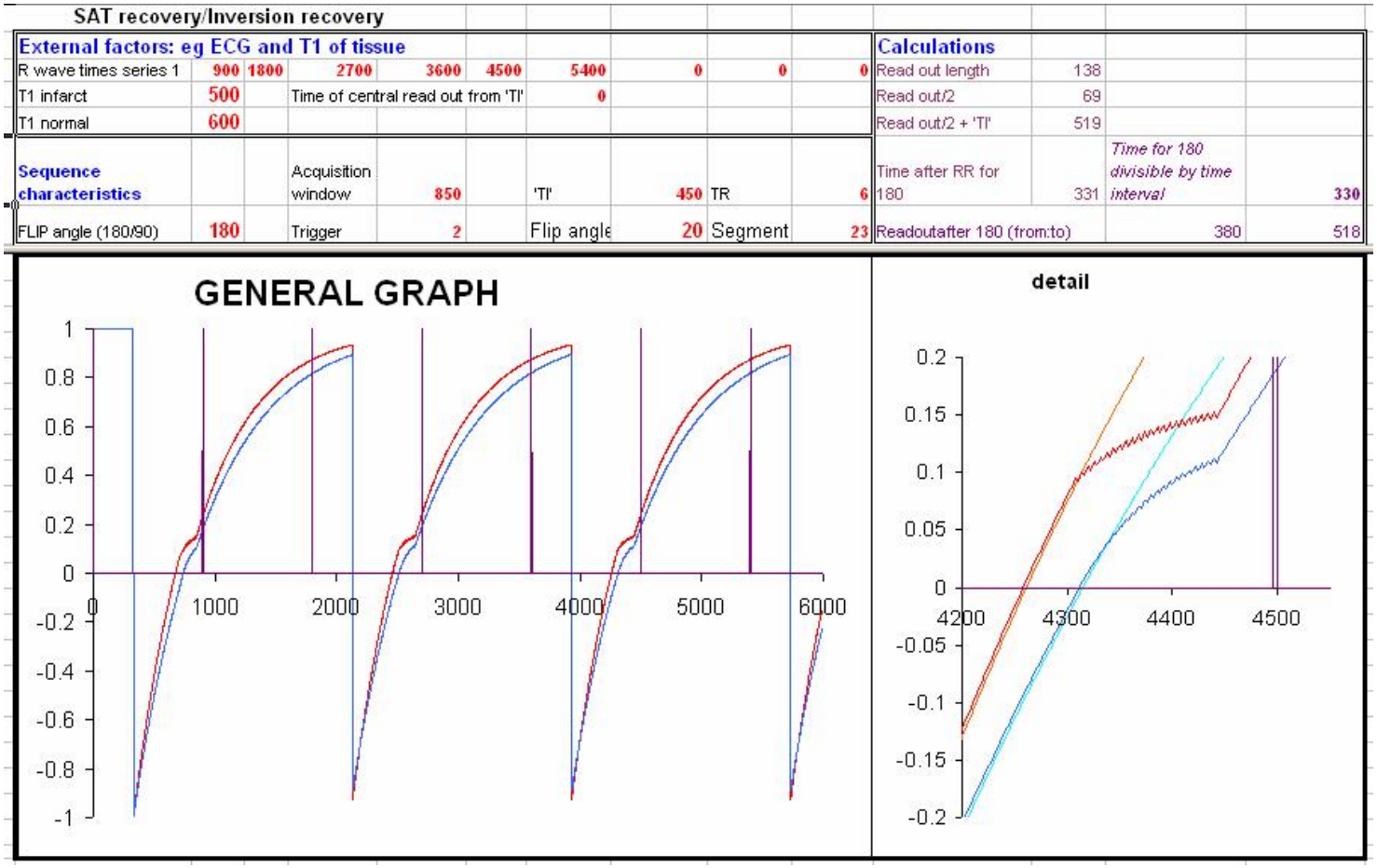
- The operator needs:
- 1. Run the scan:
- 2. Look at the picture:
  - Is the image: grainy
    TI wrong
    artefact (respiratory, CSF, wrap etc)
  - Can you interpret all segments of myocardium?
- Then either:
  - adjust and repeat
  - Phase swop
  - Or move to the next slice

Effect of the wrong TI



Question 7: a T b F c T d T e T

In the real world:



First 180

- TI=T1x0.69

Second 180

- Full recovery
- not occurred

So

- Dummy pulses
- TI shorter than T1xLn(2)

Readout

- affects T1 recovery
- centre only at null point

Question 8: a T b T c F d T e T

Artefact - Blood pool:

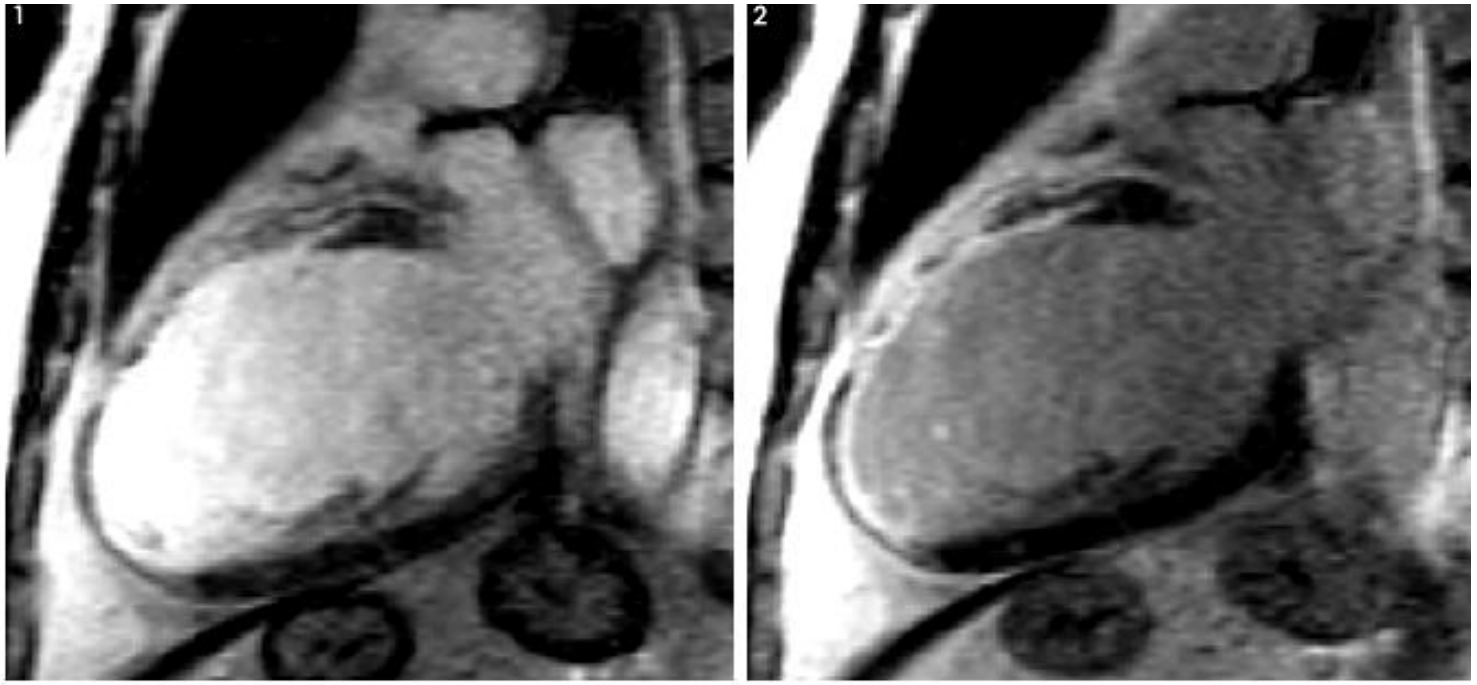


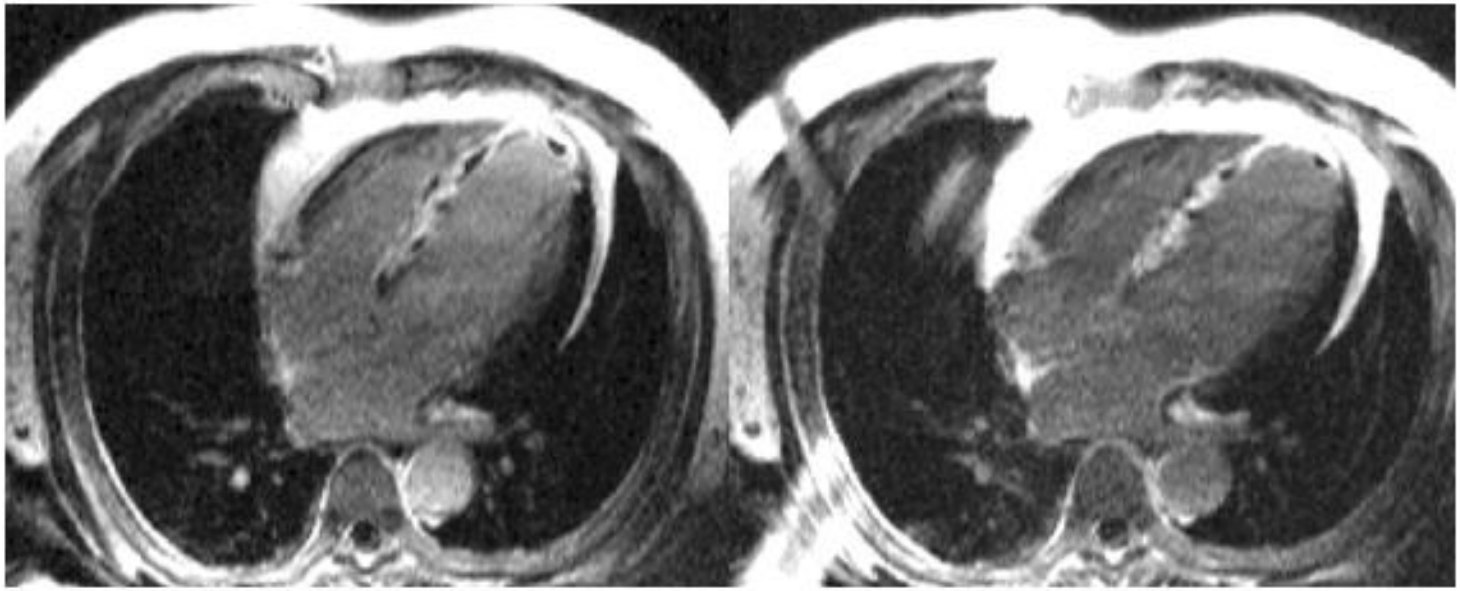
Image too early:

– blood pool still bright: infarction missed

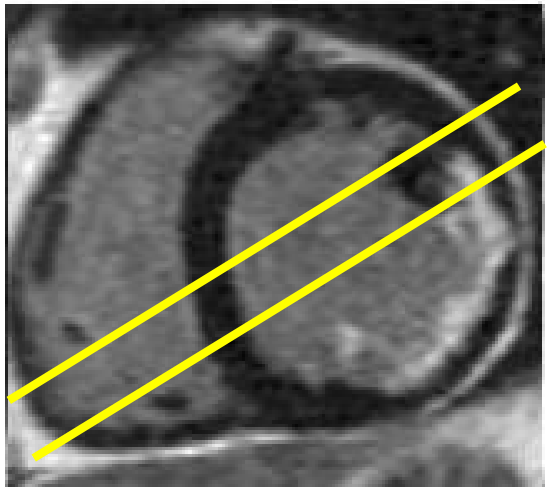
– Solution – wait and repeat

Question 9: a F b T c F d T e T

Artefact avoidance – Other sequences

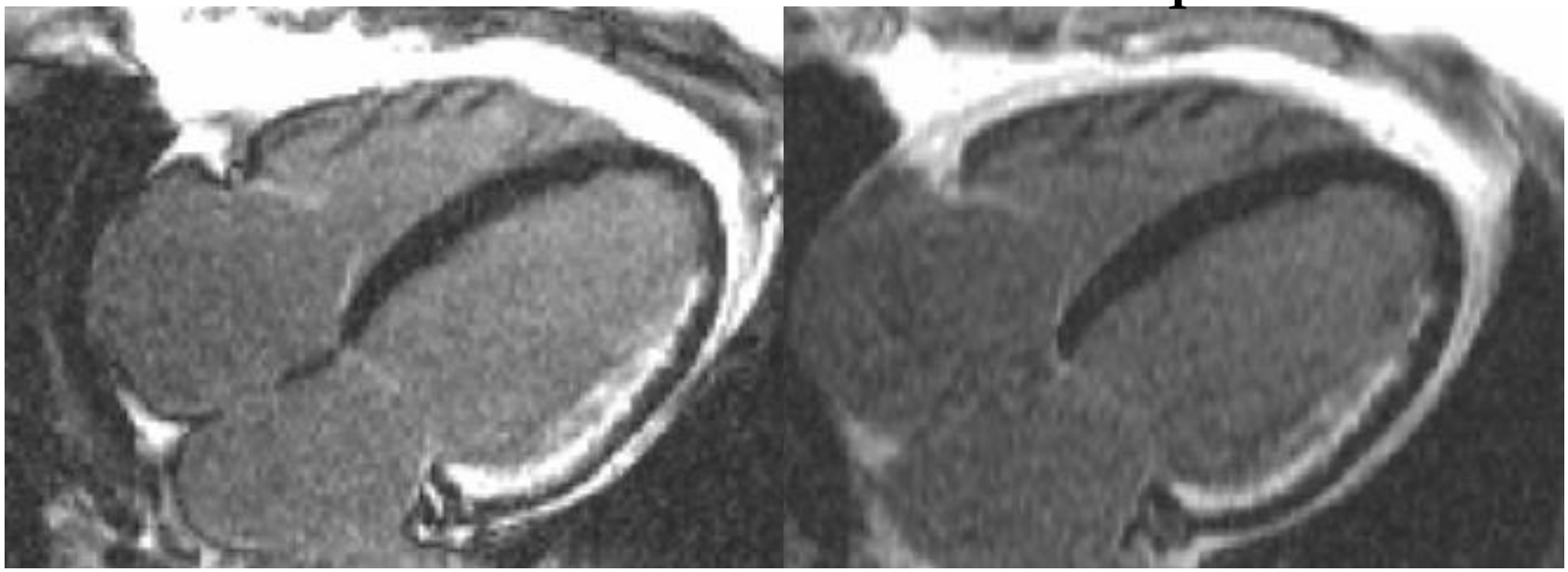


- (R) – navigated
- Note MVO
- 4ch sensitive to diaphragm position



Question 10: a T b T c F d T e T

Artefact avoidance – Other sequences



- IR-FLASH standard, other IR techniques possible
  - IR-FISP (left) – advantages in some patients – more flexible sequence
- IR-SSFP: Same IR preparation, SSFP readout.
- Readout faster, higher SNR so better patient optimisation
  - single shot (breathless patient), Trigger 3 or 4 (tachycardia or AF)
  - shorter readout (if high dose Gd early or tachycardia)
- Bright is still dead in ischemic heart disease

Question 11: a T b T c T d T e F

Thinking about future sequences

- 3d – inevitably a longer read-out
  - So worse nulling
- IR imaging is high contrast but low SMR
  - ipat/sense parallel imaging will make this worse
  - Images may become more grainy
- Phase sensitive IR may be helpful
- High sensitivity at the expense of specificity
  - Focal fibrosis; diffuse fibrosis completely missed
- Fibrosis has intrinsic contrast – hard to see in a breath-hold – so we use an extrinsic contrast

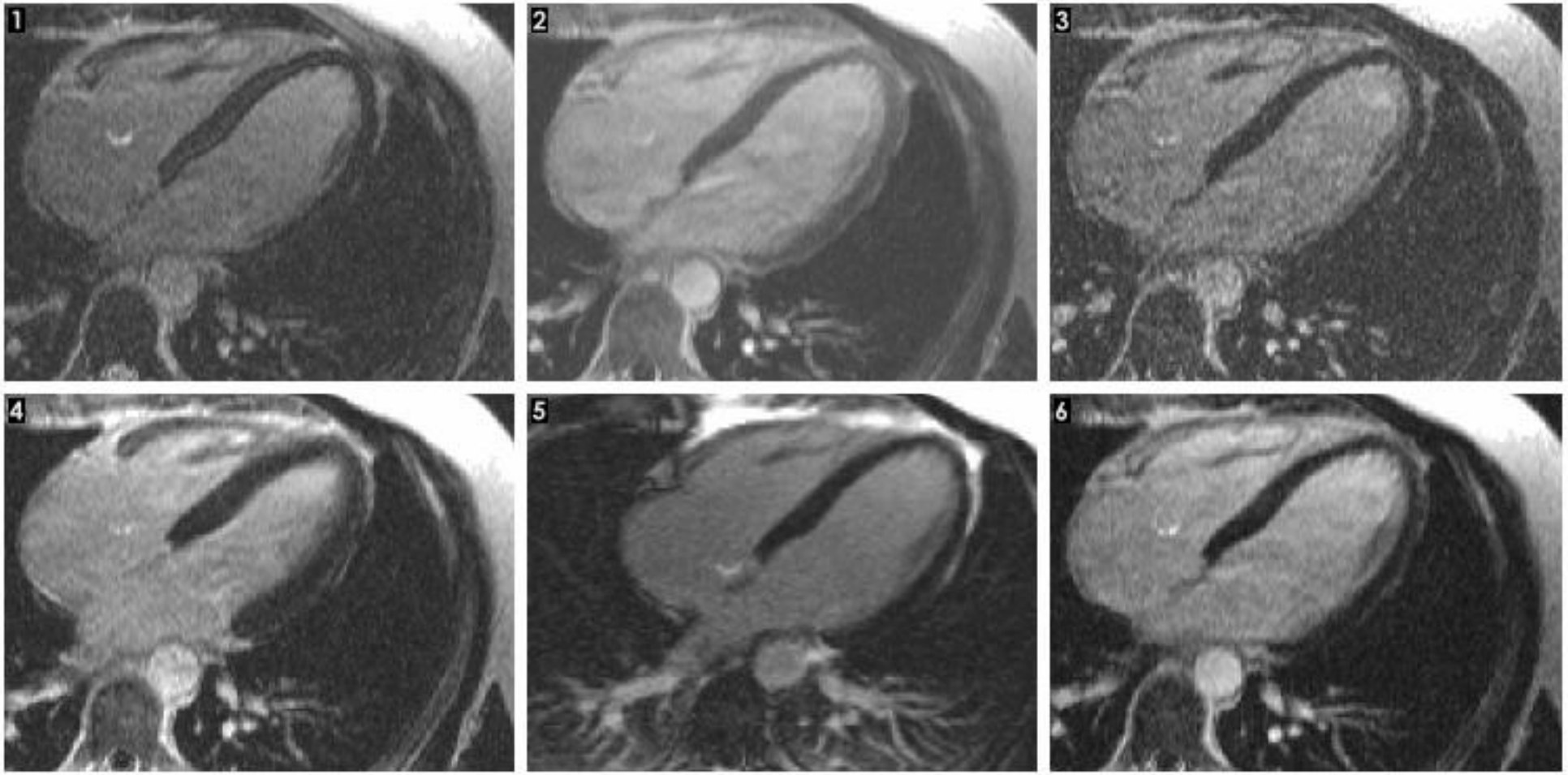
Question 12: a F b F c T d T e T

Dose of gadolinium

- Gd 0.1-0.2ml/Kg: 10 - 40mls typical
- Higher dose:
  - More expensive
  - TI will be shorter
  - Need to wait longer before imaging
  - Less heart rate sensitive
  - More likely to miss subendocardial infarction
  - (care with segmentation too high)
- Correct technique more important than dose

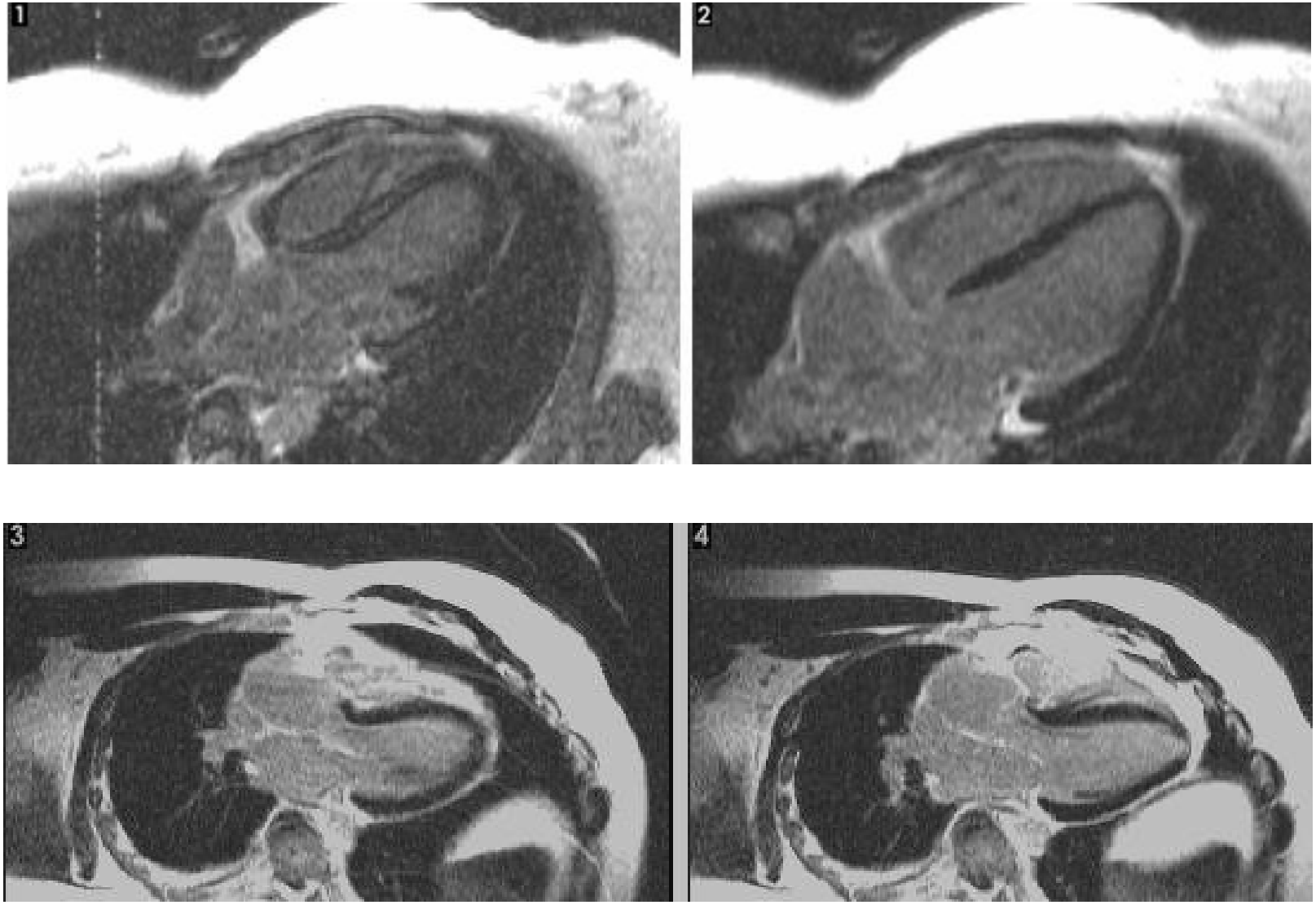
Question 13: a T b F c T d T e T

Artefacts



Question 14: a T b F c T d F e T

More Artefacts



Question 15: a T b F c F d T e T

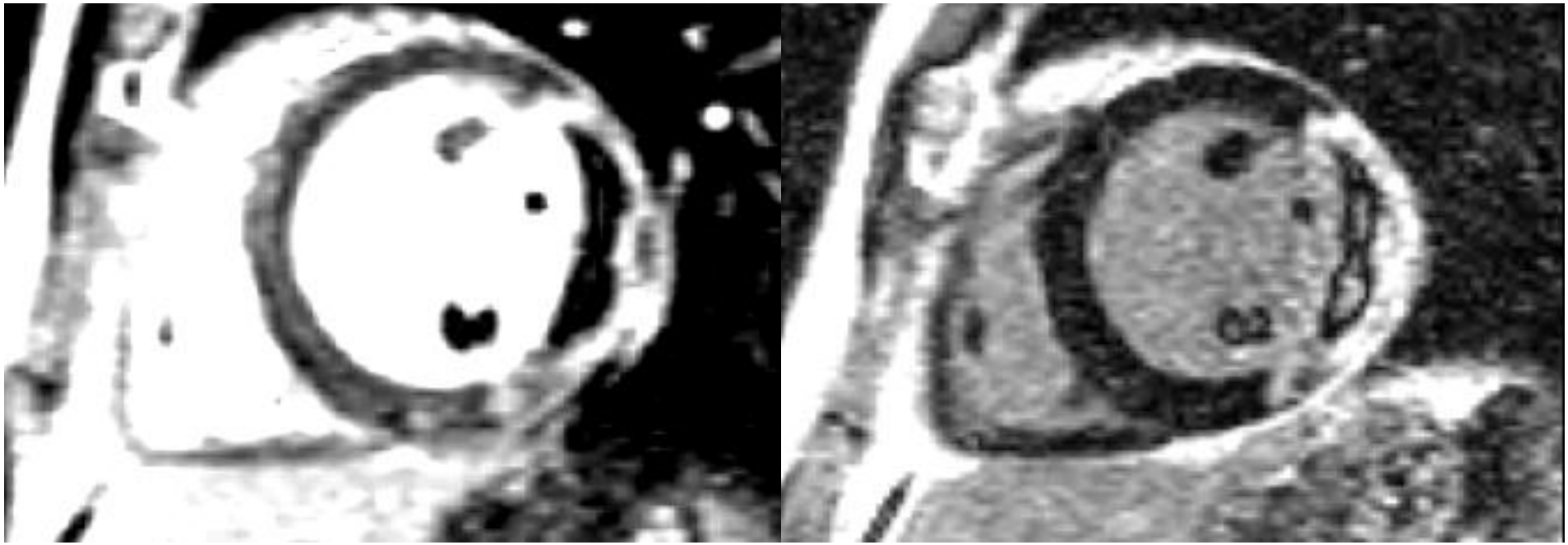
Enhancement in other diseases

Enhancement in non-ischaemic Cardiomyopathy

- 2 spots of enhancement at RV insertion points
- The 3rd point is fold-over (wrap) artefact as it disappears with phase swap

Question 16: a T b F c T d T e F (answer not truly known)

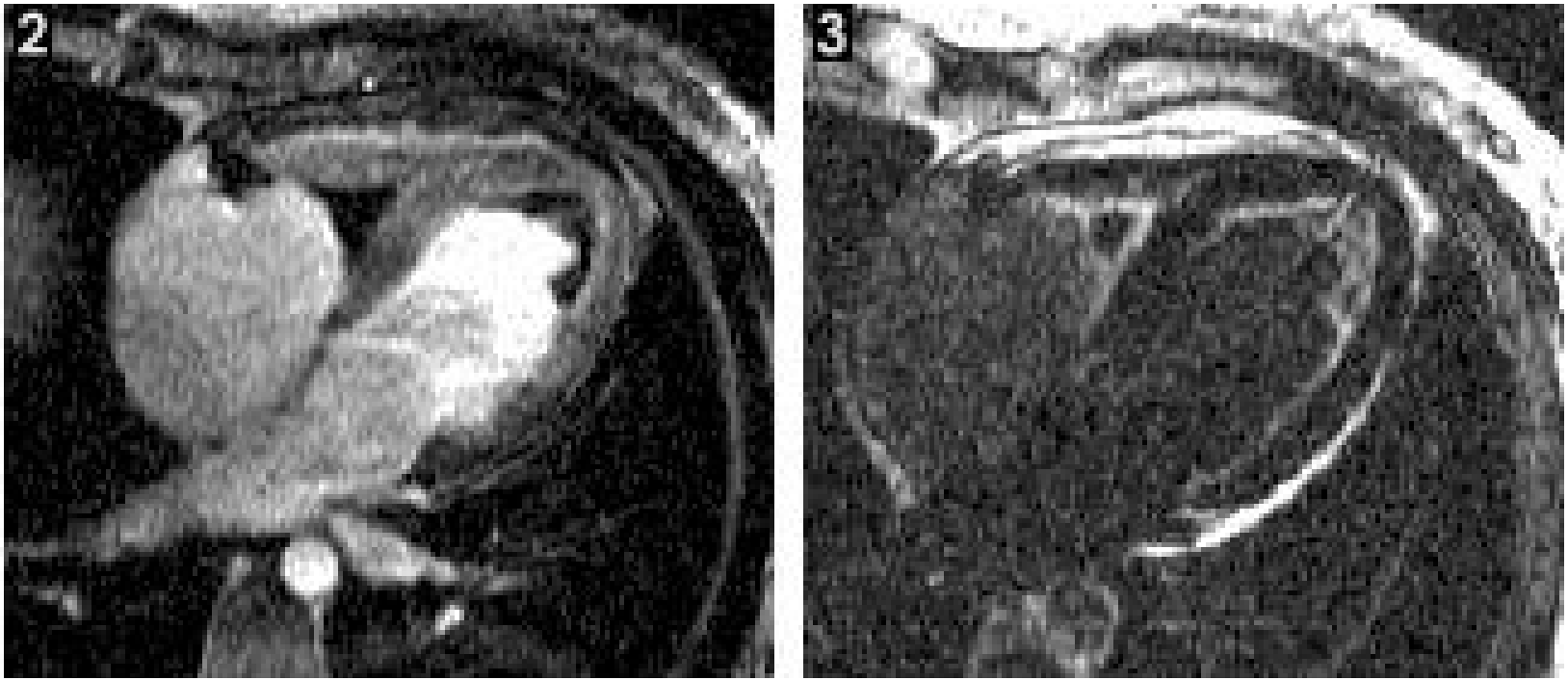
Microvascular Obstruction MVO



- In acute MI, whilst waiting, early imaging for MVO
  - Set the TI to null myocardium **without** Gd (480, 440 if HR fast or trigger 1 imaging as in 3D sequence)
  - MVO dark, all other bright

Question 17: a T b F c T d F e T

Enhancement in other diseases



The MVO technique detects avascular tissue, thrombus

Here, endomyocardial fibrosis (Loeffler's) with apical thrombus

Question 18: a T b T c T d T e F

Last 2 questions

Question 19:

a T b T c F (impossible in IHD) d T e F

Question 20:

a F(how is LGE formed in HCM – unknown.unproven) b T c T d T e T

Conclusion

- I hope you enjoyed the quiz
- Late gadolinium imaging is fun
- Go tell people their TI is too short
- Add up scores: marks out of 100
- Any errors – email me.
- See also scmr ‘members only’ documents other ‘How I do’ presentations

James C Moon James@moonmail.co.uk